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Understanding the role of Business Performance Analytics for performance management

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Abstract
Purpose - The purpose of this paper is to explore the role of Business Performance Analytics (BPA) for performance management purposes. Simons' levers of control framework (1995) is used to discuss their contribution to the diagnostic and interactive use of performance management systems. Finally, a framework that highlights central issues to be considered when developing BPA for performance management is presented.
Design/methodology/approach - The paper adopts an interventionist approach (Kasanen et al., 1993) to empirically test the proposed framework. This allowed the researchers more flexibility in moving back and forth from theory to data, in a relatively novel area of study.
Findings - The longitudinal study conducted in a company operating in the construction industry provided a number of insights to refine the framework and shed light on critical organisational issues.
Research limitations/implications - This paper is based on a single case study in the construction industry. Whilst this represents an appropriate approach given the exploratory nature of the study, further empirical investigation is needed across different industries.
Practical implications - In a context of growing importance of leveraging Big Data for improving business performance, our study has the potential to guide companies along this route. It provides insights on both the potential and challenges connected to the implementation of BPA.
Originality/value - This paper is one of the first attempts trying to investigate the potential contribution of Big Data and business analytics to promote strategic control. It develops a framework that could be used to guide further research in the area and provides an account of some of the potential challenges faced by businesses when trying to move to a data-driven approach to interactive control

1. Introduction

In the era of digitisation companies worldwide have got access to an unprecedented amount and variety of data. The world "Big Data" has been coined to describe this high-volume, high-velocity, high-variety of information. Globally produced data are expected to double every 18 months, with data volume processed by organizations expanding by 35-50% per year (Manyika et al., 2011). Technology is changing the rules of business and how to transform data into knowledge and inform decision making has become a key issue (Davenport et al., 2010). There is growing consensus that data presents huge potential for

management accounting (CIMA, 2014; Bhimani and Willcocks, 2014) as the employment of analytical tools may transform it and inform decision-making processes.

Despite this recognition, academic research investigating Big Data and analytics for management purposes is still scant. The novelty of the topic and the scepticism surrounding the Big Data field may explain such limited interest. Besides, previous research investigating CRM systems and ERPs had already called into question the idea that the automatic capture, manipulation and dissemination of real time information could lead to any of the promised benefits of cost savings, increased profits, smaller inventories, more effective sales strategis (Davenport 1998; Buckhout 1999; Brady 2001; Gefen and Ragowsky 2005) and improved decision making (Grant et al. 2006). Non-strategic alignment (Lucey 2005, Phrahald and Krishnan 2002) of data and excessive focus on the "hard" aspects of information systems (Davenport 1997; Orlikowski 2000) have been linked to such failures.

With particular reference to the role of IT systems and Big Data in supporting a specific area of management control, that is Performance Measurement Systems (PMSs), critical issues arise. It is now well established that PMS can play a strategic role and support both the implementation of strategy and its (re)formulation. In other words, PMSs have two distinctive -but interdependent and complementary- contributions (Simons 1995). First of all, PMS's core function is to control the achievement of organisational goals and correct deviations from predefined target of performance. This role is usually described as "diagnostic" and refers to the monitoring of deliberate strategies (Mintzberg, 1978). However, for PMSs to be effective, a more active, feed-forward role has to be played. This refers to the ability of PMSs to be used "interactively" as to question the strategic assumptions, promote strategy (re)formulation and support emergent strategies (Mintzberg, 1978).

Research on the diagnostic role of PMSs shows growing diffusion of comprehensive PMSs and provides evidence of more informed assessments compared to conventional, financial-focused control systems (Gimbert et al., 2010). However, their implementation in practice still results in unsatisfied operational and strategic information needs (Silvi et al. 2014). Inappropriate PMS design and management processes fail to capture the key business success factors and can lead to expensive (compared to the benefits) and even harmful systems. Inability to capture the key business success factors, unclear impact on business performance, simplistic definition of linear cause-effect relationships between financial and non-financial measures, and a focus on the past and on the short-run are the most common weaknesses of PMS observed in practice. Yet, this attention on the diagnostic role of PMSs has been called into question and a number of scholars have argued on their actual ability to work in the modern and dynamic business environment (Micheli and Manzoni, 2010; Bisbe and Malagueño, 2012). In fact, PMSs may promote over-commitment to the stated deliberate strategy and create organizational inertia (Townley et al., 2003; Micheli and Manzoni, 2010). To date, less emphasis has been placed on the interactive use of PMSs and a limited number of studies have explored their support to foster organizational learning and support emergent strategies (Tuomela, 2005; Gimbert et al., 2010; Bisbe and Malagueño, 2012; Kominis and Dudau, 2012).

Our work moves from previous considerations about (1) the limitations of practical implementations of IT systems in supporting Big Data analysis and about (2) the lack of attention on the interactive role of PMSs. This paper positions itself in these emerging streams of literature, with a first aim to understand whether the integration of business performance analytics (BPA) within PMSs can promote strategic control. We define BPA as the controlling of business dynamics and performance through the systematic use of internal and external data and analytical methods (Silvi et al., 2012).

With this in mind, our second aim was to contribute to the literature by developing a framework to operationalize the integration of BPA within PMSs, drawing on Simon's model

of levers of control (1995). Based on the idea that control systems should be contingent upon a wide range of factors (Otley, 1980; Chenhall, 2003), we do not propose a prescriptive, ideal model/framework for BPA. Rather, and coherently with previous contributions in the area of performance management (Ferreira and Otley, 2009), we propose a series of issues to be considered when designing and implementing BPA.

By adopting an interventionist approach (Kasanen et al., 1993), we empirically tested our framework in a company operating in the construction industry. This allowed the researchers more flexibility in moving back and forth from theory to data, in a relatively novel area of study, and contributed to a more an in-depth understanding of the potential and limitations of the framework proposed.

To summarise, this study makes three broad theoretical contributions. First, it contributes to the understanding of how Big Data and business analytics can contribute to the strategic role of PMSs. It proposes a framework that theorizes the use of Big Data and business analytics (BPA) for performance management purposes. In particular, by identifying a series of steps in the development of BPA, the framework is intended to help conduct research that explores the potential of Big Data and analytical tools in the design and use of PMSs. Secondly, it addresses the call for a better development of the theory about the use of control systems (Ferreira and Otley, 2009) and for additional studies specifically exploring the notion of "interactive control". Thirdly, the paper contributes to the emerging literature on interventionist research in management accounting.

This paper is structured as follows. The next section outlines the theoretical foundations of the work and presents in details a BPA framework developed by the research team. The third section describes the research methods and the data collection process. Empirical findings and their discussion are reported afterwards. To conclude, a number of theoretical and managerial implications are presented in the final section.

2. Theoretical Framework

2.1 The Big Data revolution and its implications on IT systems and PMSs

Management accounting concerns the use of information to help managers carry out their duties and activities and make their strategic and operational decisions. The information usefulness is affected by the ability of IT systems to properly select and elaborate data and, at the same time, by the data availability. On this second point, the amount of data available to organizations has been expanding rapidly and will continue to grow exponentially for the foreseeable future (Manyika et al., 2011). Digital data is now everywhere – in every sector, economy, organization and user of digital technology. As soon as information becomes more fine-grained and updated, decision makers should give more emphasis on it and the overall quality of decision should improve, changing from intuitive management to more numbers-driven decision-making. Growing evidence suggests that leading users of Big Data for decision-making are achieving higher returns compared to their competitors (Brynjolfsson et al., 2011), through the levers of innovation, competition, and productivity. Big Data levers can deliver value along the business value chain in terms of cost, revenue, fixed assets and working capital, involving marketing (cross-selling, location based marketing, in-store behaviour analysis, sentiment analysis, etc.), R&D design (product life cycle management, design to value, open innovation, etc.), supply chain management (inventory management, demand forecasting/shaping and supply planning), production (sensor-driven operations, digital factory, etc.), after-sales services (product sensor data analysis, etc.).

The advanced operating and accounting systems are now available economically as cloud-based solutions, as a consequence also small businesses are accumulating digital data about their customers and operations. There is much attention on new data-enabled business models, for global and smaller-scale businesses.

In this context, the ability to store, aggregate, and combine data and then use the results to perform deep analyses has become more and more strategic, in order to take advantage of Big Data potential and to leverage it to value creation. In the last few decades, companies have been implementing significant investments in their IT systems, in form of Enterprise Resource Planning (ERP), Business Intelligence (BI) tools, inter-organizational sharing mechanism, databases and web-based software packages. These systems could support operations modelling in real time (Berry et al., 2009) and enhance decision-making, either through the integration of different databases (Chapman and Kihn, 2009) or through offering new information (Hyvönen, 2007). However, despite their potential benefits, empirical evidence of IT systems' effectiveness is at least equivocal (Seufert and Schiefer, 2005, Grant et al., 2006; Beaubien 2012). Therefore, the relationships between management control and new IT systems needs to be better explored, both theoretically and practically (Berry et al., 2008).

Given this information technology progress, for most of companies now the priority is how to better interrogate the accessible data on their systems. In fact, even if Big Data offers an unprecedented level of potential relative to the provisioning of diverse, voluminous and sophisticated analyses, often only one or a few measurements are focused on, which leads to an unbalanced view of organizational performance. Various internal and external factors seem relevant, especially in a strategic setting; these challenges decision-makers' identification of key performance drivers to focus on. Moreover, even when internal and external factors that affect results are monitored, organizations often do not use the data effectively (Davenport et al., 2010). The too internal focus, which neglects environmental factors and the extended value chain, does not allow managers to understand where and how value is created in the business.

Current dynamic and complex environments are characterized by various interdependencies between strategic factors and, when considered in strategic and operational decisions, are frequently based on subjective and incomplete assumptions (Klatt et al., 2011). Smith and Goddarb (2002) note that, consequently, performance data is useless; it has to be converted into meaningful and robust performance signals.

Coherently, talking about challenges that organizations should face in order to effectively implement their PMSs, Neely (2013, https://www.youtube.com/watch?v=pW7ApWW4HdI, accessed 13th July) points out how a first relevant issue is technologies and its ability to manage Big Data: with the continuous development of the web technologies, data are generated from all the web sources and not only inside the firm. The attention of the organizations should be more and more focused on social media to get feedbacks on particular product or services. In his opinion, another key point is what to measure; it is extremely import to choose what really matters for the organization, and the starting point is the company strategy. This is what Neely defines "framing in a strategic context".

In sum, with particular reference to the area of PMSs, Nudurupati et al. (2011) underline the reasons why, despite the amount of research and interest, they still remain unsatisfactory. Reasons are related to the inability of the IT systems to provide an adequate information flow. In detail, PMSs are not dynamic and sensitive to changes in the internal and external environment of the firm (Marchant and Raymond, 2008); as a consequence, the information is not relevant, up-to-date or accurate and doesn't facilitate fast and confident decisions by managers.

2.2 PMS and strategic control

Managing the tensions between the control of predictable goals and the flexibility required for creative innovation is the essence of management control (Simons 1995). On the one hand, control systems promote the delivery of deliberate strategies (Mintzberg, 1978) and act "diagnostically" in order to identify deviations from the stated objectives. Diagnostic control systems are therefore characterized by three main characteristics (Simons, 1995, p. 59): (1) the ability to measure the outputs of a process; (2) the existence of predetermined standards against which actual results can be compared; (3) the ability to correct deviations from standards. On the other hand, overemphasis on this aspect is likely to constrain opportunity-seeking and fail to capture strategic uncertainties (Micheli and Manzoni, 2010). Control systems are therefore required to have a proactive role and stimulate search and learning (Simons, 1995) too. This "interactive" function allows strategies to "emerge" (Mintzberg, 1978) as different individuals throughout the organization respond to perceived threat and opportunities. According to Simons (1995), these systems have four distinctive characteristics (1995 p. 97) (1) information generated by the system is an important and recurring agenda addressed by the highest level of management; (2) the interactive control system demands frequent and regular attention from the operating managers at all levels of the organization; (3) data generated by the system are interpreted and in discussed face-to-face meetings of superiors, subordinates and peers; (4) the system is a catalyst for the continual challenge and debate of underlying data, assumptions and action plans.

Most of the discussion around the role of PMS for strategic control has centred on their diagnostic function. A number of PMS frameworks have been developed, from Performance Pyramids and Hierarchies (Dixon et al., 1990; Lynch and Cross, 1995), to Tableau de Board (Epstein and Manzoni, 1998) and Balanced Scorecards (BSC, Kaplan and Norton, 1992). All of them aim to set up a dashboard of measures able to support the day-to-day decision making, describing the firm's objectives, encouraging coherent behaviours, and measuring results. Available data suggests widespread adoption of comprehensive PMS (Rigby and Bilodeau, 2009) which has been claimed to have beneficial impact on performance (Hoque and James, 2000; Chenhall, 2004; De Geuser et al., 2009).

However, research has started to question the emphasis placed on this traditional role of PMS which may generate over commitment to the deliberate strategy and promote organizational inertia (Norreklit, 2000; Townley et al., 2003; Micheli and Manzoni, 2010). Addressing this issue has been considered particularly pressing (Bisbe and Malagueno 2009; Melnyk et al., 2014) as organizations operate in increasingly dynamic and volatile environments. Inability to capture the key business success factors, unclear impact on business performance, simplistic definition of linear cause-effect relationships between financial and non-financial measures, and a focus on the past and on the short-run are the most common weaknesses of PMS observed in practice. Research investigating the "interactive" role of PMS is still scant and only a few studies explores their contribution to strategy (re) formulation and support emergent strategies (Bourne et al., 2000; Campbell et al., 2008, Kaplan and Norton, 2008; Gimbert et al., 2010; Bisbe et al., 2012). Case-based evidence suggests that PMS can be used to challenge mistaken assumptions (Bourne et al., 2000). On the same line, large scale findings support the idea that causal, multi-perspective PMS and their informational effect helps frame senior manager's mental representations and impact the variety of decision taken in each strategic review (Gimbert et al., 2010; Bisbe and Malagueno, 2012). that PMS can actually promote interactive control and stress the relevance of causal-effect linkages in this process,

2.3 Integrating Big data, business analytics and PMS for strategic control

Prior studies indicate that PMS can actually promote interactive control and stress the relevance of causal-effect linkages in this process. However, at an instrumental level, it is not clear how this translates into the design and use of PMS. The notion itself of interactive control has been considered ambiguous (Bisbe et al., 2007; Tessier and Otley, 2012) and more research has been called for to develop and operationalise this concept (Ferreira and Otley, 2009).

In today's complex and volatile business environment, the availability of up-to-date and accurate performance information have become a critical success factor (Nudurupati et al., 2011) and are increasingly considered essential to support and promote a pro-active management style. Big Data are believed to have great potential but research has demonstrated in the past that the automatic capture, manipulation and dissemination of real time information is not sufficient to deliver such benefits (Grant et al 2006). Non-strategic alignment (Lucey 2005, Phrahald and Krishnan 2002) of data and excessive focus on the "hard" aspects of information systems (Davenport 1997; Orlikowski 2000) have been linked to such failures.

Despite the widely acknowledge role that data can play for performance management purposes, attempts to combine theories of PMS and information systems are limited (Bititci et al., 2006; Marchand and Raymond, 2008; Nudurupati et al, 2011; Schläfke et al., 2011).

In this context, we propose the introduction of Business Performance Analytics (BPA) as a framework to support effective PMSs design and adoption (Silvi et al., 2012). We define BPA as the control of business dynamics and performance through the systematic use of data (also micro-level data) and analytical methods. More precisely, according to Davenport (2007, p. 7) analytics (i.e. decision support systems, expert systems, data mining systems, probability modelling, structural empirical models, optimization methods) represent "the extensive use of data, statistical and quantitative analysis, explanatory and predictive models and fact based management to drive decisions and actions".

BPA emphasise the use of multiple analytical methods related with mathematics, statistics, econometrics, to support the control of business dynamics, both at the operational and strategic level. While operational BPA examples are analytical applications related to yield management in the hotel industry, to the trading of commodities in the metal industry or to the prediction of process/plant failures, concerning day to day activities, strategic BPA, on the other hand, support strategy (re)formulation, implementation and control. Therefore, they provide insights about business model's key success factors and opportunities/threats, such as markets' and competitors' dynamics and change, pricing and value creation, supply chain opportunities or risks, markets and customers, R&D and innovation (May, 2009), human resources, marketing, supply chain management (Trkman et al., 2010).

According to Klatt et al. (2011), in order to be successful, BPA applications should address the following three key weaknesses of PMSs observed in practice:

- *information overload* from the perspective of decision-makers, since a number of internal and external variables appear relevant, especially in a strategic decision setting. Due to a massive information availability, paradoxically the identification of primary aspects can represent an issue (''we measure everything that walks and moves, but nothing that matters'', Neely, 1999, p. 206). BPA should add to the selection of relevant leading performance drivers and indicators;
- *the absence of measured casual interdependences* between strategic impact factors, which are often subjectively assumed and on incomplete basis. As a result, data appears worthless if not converted into sensitive financial performance impacts (Smith and

Goddard, 2002). From this point of view, BPA should help the identification of causal effects between impact factors expressed in qualitative/non- financial terms and strategic target measures;

- *the lack of an holist view of the organization* and of its different inputs, processes, outputs, and outcomes, connected by critical interdependencies. Having to satisfy multiple objectives which express complex company strategies, multi-dimensional drivers of performance need to be bounded into a systematic PMSs. On this side, BPA could improve strategic and operative planning and measurement by empirical foundation of the underlying cause-effect relationships between key success factors.

Furthermore, Sahai and Ranja (2008) underline that an analytical decision-making is essential. «Success requires more than just knowledge of statistics or ways of dealing with "Big Data". Execution is essential, but without a plan and commitment, little happens. Success also requires an understanding of how analytics translates to competitive advantage» (Stubbs, 2011). In sum, performance measurement using analytical tools is not enough to obtain a competitive advantage. PMSs need to capture business dynamics, value creation opportunities, as well as potential threats and risks.

2.4 A framework for analytical performance management

Based on the previous considerations, we draw on Ferreira and Otley's framework for performance management (2009) to theorize the integration of BPA within PMS systems for interactive control. Our choice of Ferreira and Otley (2009) is motivated by a number of reasons. First, they adopt a holistic view of performance management, which looks at the totality of control systems and accommodate both the diagnostic and interactive use of PMS. Second, the link between PMS, and strategy, and key success factors is pivotal. Third, it recognizes the role of information systems to support PMS. Fourth, their framework does not impose an ideal solution. Rather, they indicate a number of issues which should be considered when designing and implementing PMS. How organizations address these issues is then contingent to their specific conditions.

However, the broad nature of their framework, while forming an essential basis for studying PMS design and implementation, leaves scope for further developments. In particular, the link between PMS and information systems is not thoroughly discussed and neither is its contribution to promote control. The level of subjectivity of data and information involved in the decision making process about the PMS design -eventually based on simple management perceptions or qualitative assumptions- could deeply affect the significance of the decision made. This is the domain where BPA express their key contribution, enhancing the quality of data and information, as first, and supporting a rational decision making approach, afterwards. In this context, BPA can add to the solidity of the information system supporting interactive control, setting forward-looking performance planning, based on robust analysis of cause-and-effect relationships. The issues become where the organization wants to be in the future and how to reach those goals, instead of just reviewing past actions.

We therefore extend Ferreira and Otley's ideas by proposing a framework for BPA. This highlights central issues that, in our opinion, need to be considered as part of the process of developing a coherent structure for performance management systems. The first area addressed is the business model assessment (step 1). The second area relates to the identification of the key questions raised by the business performance model analysis (step 2). The third area draws attention to the data need and collection (step 3). The fourth area concerns the design and development of the analytical methods and tools (step 4) and, finally,

the last step relates to the assessment of the Performance Management Systems elements and characteristics (step 5).

Step 1. Business Model Assessment

The business model can be defined as a "concise representation of how an interrelated set of decision variables in the areas of venture strategy, architecture, and economics are addressed to create sustainable competitive advantage in defined markets" (Morris et al., 2005, p. 727). According to the Authors, it has six fundamental components: value proposition, customers, internal processes/competencies, external positioning, economic model, and personal/investor factors.

As for business model representations, several authors have attempted to represent it through a mixture of informal textual, verbal, and ad hoc graphical representations (e.g., Amit and Zott, 2002). For instance, Weill and Vitale (2001) introduce a set of simple schematics intended to provide tools for the analysis and design of e-business initiatives. Similarly, Tapscott et al. (2000) suggest a value map for depicting how a business operates; it should represent all key classes of participants (partners, customers, suppliers) and value exchanges between them (tangible and intangible benefits and knowledge).

The definition of a company business model and its analysis are essential to the description of the business performance model, with particular emphasis on performance drivers. As suggested by Neely (2013, https://www.youtube.com/watch?v=pW7ApWW4HdI, accessed 13th July), in order to implement an effective and efficient PMS in such a changing environment it is fundamental to frame the strategic context of the system, being really clear about the organizational strategy, and its linkages with the measures to be used and their behavioural consequences, in terms of whether the measures used will drive the right decisions of actions to allow the execution of the strategy stated. This knowledge is valuable to the second step of our framework: the identification of key success factors and the related key questions.

Step. 2 Identify the key questions

Previous steps provide insights into the performance generation model and a general view of the main performance drivers, to frame the strategic context of PMSs. They support the identification of the key questions to answer in order to understand the root causes of current and future performance. The objective is to manage drivers more effectively and, then, improve performance, from a multidimensional point of view.

Key questions lead to the company data needs.

Step. 3 Data needs and collection

This step concerns the analysis of data availability and sources. The source can be internal (company ICT, Internet of Things, Digital and Social) or external (Social and Digital open data), structured through proper IT systems -like ERP and BI tools- or not (just Big Data). According to Syed et al. (2013) Big Data consists of unstructured data for about 90 percent and includes soft information, such as email messages, social media postings (like blogs, tweets, Facebook entries), phone calls, website traffic, and video streams. Moreover, data can have different forms: video and image data, audio data, textual (Warren et al., 2015).

In this context, data availability is a key issue, together with our previous considerations about the *relevance*, the *reliability* and the *timeliness* of the information provided by current and potential future IT systems. According to IFAC (2011) the characteristics of the IT system structure presents some critical issues. As first, forward-looking information has to be *relevant* for decision making regarding relevant business issues and decisions. Secondly,

reliability - predictability - has to be ensured, through standard and consistent processes to create the analysis. Thirdly, timeliness is crucial (Seufer and Schiefer, 2005).

Step. 4 Design and develop the analytical methods and tools

In order to become valuable, data need to be properly transformed in information useful to answer the key questions previously identified.

The literature (Gartner Report 2012) has identified four types of analytics that can aid business:

- *Descriptive analytics* – These analytics implementations are typically based on past and real-time data. Useful analytical techniques could be: (1) standard reporting and dashboards (e.g. budget, sales, revenue and costs) that answer questions like "What happened?", "What is happening now?", "How does it compare to our plan?"; (2) ad-hoc reporting to explore issues like "How often does a certain event occur?", "How many?" and "Where?". Descriptive analytics provide significant insight into business performance, therefore they are important to enable business users to better monitor and manage business processes. However, they rely only on present and past, not on future. This is why this type is often considered the initial step to serve a successful application for next analytics typologies.
- *Diagnostic analytics* – They provide a look at past performance to determine what happened and why, through analysis/query/drill-down, to solve dilemmas like "Why does it happened?", "What exactly is the problem?".
- *Predictive analytics* – These analysis provide scenarios of what might happen. The deliverables are usually predictive forecasts. According to Davenport and Harris's idea, through an extensive use of data and statistical techniques the company can achieve explanatory and predictive models of business performance, using various advanced techniques to segment data (clustering, decision trees, and neural networks) in order to make "predictions" about the future, based on the past. Examples of techniques are: Monte-Carlo simulation; data mining examining scenarios in time series; pattern recognition and alerts; forecasting; root cause analysis.
- *Prescriptive analytics* – This type of analysis aims at revealing what actions should be taken. This is the most valuable kind of analysis, thanks to robust techniques to facilitate the understanding to what might happen in the future. It usually results in rules and recommendations for next steps.

Step. 5 Define the Performance Management System

Previous steps contribute to the definition of elements and characteristics of the Performance Management System: strategic factors to be monitored, strategic dashboard content, relevant data and analytical tools.

However, for BPA to be effective they need to be linked to the overall PMS. In other words and as for any type of control instrument, issues concerning organizational responsibilities, performance evaluation, reward systems are as important as the "hard" aspect of measurement. Here we specifically refer to questions 3, 7 and 8 discussed in Ferreira and Otley (2009).

3. Research methods

This paper is based on a case study (Building Consortium -BC-), a method that offers an holistic orientation (Yin, 2008) and the possibility of understanding the actual role, in practice, of business analytics in supporting management accounting systems. This goal

requires an in-depth understanding of the company observed and, in particular, of the inter-relationships between a large number of elements that characterize that complex social system and that should be studied in their particular context (Scapens, 1990). It also requires a combination of methods of collecting research materials (observations, interviews, document analysis), both of qualitative and quantitative nature.

Moreover, case studies are particularly advocated in areas where theory is not very developed yet, like the case of business analytics. Choosing this method we looked for a theoretical generalisation (rather than a statistical generalisation); thanks to our individual case study we aimed to contribute to the generation of theories (Eisenhardt, 1989), to be retained, used and tested in future additional cases. Our focus was on the production of an original solution for BC, based on previous theories and cases, adapted to its actual situation, and potentially generalised and diffused to other cases, to make a theoretical contribution (Jönsson and Lukka, 2006; Labro and Tuomela, 2003).

In conducting our research, we adopted an interventionist approach. The complex social context of any firm suggests that a more complete understanding can be achieved through a direct and substantial interactions with the selected organization and its members (Anderson and Widener, 2007). According to this, the researchers took part in the implementation process in BC of a framework for improving the role of business analytics in supporting management accounting systems, being involved in something that was going on. This particular circumstance enabled penetrative insights (Parker, 2012) and gave us the opportunity to gain a better understanding of the on-going process and to observe real participants' actions and opinions (Jönsson and Lukka, 2007). Argyris et al. (1985, p. XII) suggests that the best way to learn about the world is to set it into change, since «change processes force issues to surface and people involved tend to need to explicate their interests and agendas, as well as mobilise their resources» (Suomala et al., 2014, p. 305). Moreover, the collaboration between researcher and the organization examined -typical of interventionist research- facilitates better access to the company and to the data and promote engagement between practitioners and researchers; this can lead to the development of innovative knowledge in collaboration (Van de Ven and Johnson, 2006; Van de Ven, 2007).

In addition, as researchers we intentionally sought to make an impact on the real world, in order to gain knowledge (Argyris et al., 1985; Van Aken, 2004; Jönsson and Lukka, 2006). Nevertheless, we linked our findings to the theoretical frame introduced in previous sessions, in order to contribute to it. Our aim was to find a balance between the emic and the etic domains influenced by the parties involved.

Our interventionist approach was intended to locate interesting questions and issues in the field, highlighting aspects that might be otherwise neglected, on the one hand. But, on the other hand, interventions was also used to examine a theoretical framework, and to explore the boundaries of extant embryonic theories on BPA.

The interventionist approach chosen also allowed the researchers to maintain a certain level of flexibility in the research framework formulation, optimizing the potential of our field study. This strategy fits particularly in with a case-based fieldwork as well (Berg and Lune, 2012, pp. 22–26)

3.1 Research Site

Building Consortium (BC) is a consortium of more than 300 large, medium and small cooperatives operating in the Italian construction industry. It was founded in 1911 and its main goal is to contribute to the growth and development of its associates in accordance with ethical, social and environmental corporate responsibility principles. This translates into BC's core activity of acquiring construction works on behalf of its associates at local and

national level. As public construction works normally are assigned on a bidding basis, BC's initial role is to study and select potential bids for its associates, prepare the bidding strategy and submit the relevant documentation. If the tender is accepted, then BC transfers the work to one or more of its associates whilst remaining responsible for the coordination and general administration of the construction project. On the one hand, BC handles the relationship with the contracting authority in terms of submitting work progress reports, setting up the related insurance policies, invoicing and collecting payments. On the other hand, BC provides support to the contractors for the periodic submission of the relevant documentation to the contracting authority and supervises the progresses of the works.

Over the 2009-2012 periods BC's financial performance suffered a progressive decline Both external and internal factors were deemed responsible for such a decrease. First, revenues were affected by the general crisis of the construction industry which badly hit the demand and BC's associates. Secondly, internal operating costs experienced an upsurge following the gradual expansion of BC's activity. This was accompanied by the perception that the current process configuration and the IT instruments available were no longer suited for a larger organization. Indeed, there was a general sentiment of increasing inefficiency in the management of both the pre- and post-bid phases due to a number of reasons: loose relationships between some departments, lack or delay of key information, duplication of activities and increasing number of mistakes. Thirdly, over the past two years the company started focusing on more complex bids and as a result the success rate seemed to decline

BC's initial response to this situation was to deeper investigate potential sources of inefficiency and consider the opportunity of reorganizing its operations. At that time the GM was attending a MBA course and was completing the strategic management accounting module. It came quite natural to bring up some of the BC's issues during a lecture where innovative approaches to performance measurement were debated. This initial contact led to a number of calls and meetings with the researchers where the possibility to create a long-term research project was discussed. On the one hand, BC was not simply interested in understanding potential sources of inefficiencies and finding an alternative configuration of its processes. There was the perception that a broader approach to the measurement of BC's performance was necessary to face a changing environment and support the information needs of a larger organization. BC's approach to PM was quite conventional in the sense that the control activity was mostly conducted through accounting measures of performance. On the other hand, the researchers were looking for a research site willing to provide ample, long-term access and where the BPA theoretical framework presented in Section 2 could be empirically tested.

3.2 Data Collection

The project was conducted by the Authors between September 2013 and December 2014. The GM of the company was the sponsor of the project and the gatekeeper. His role, however, was not merely to ensure researchers access to the company and commitment to the project. The GM had a major involvement in the critical discussion of the research findings at various stages and developing a "practically relevant" solution for the company. The GM was enthusiastic about the project and personally stood up for its launch in front of the board. Therefore he was personally interested in ensuring the project's success. Other than the GM, the project team involved: (1) Four academics – the Authors – and (2) the company's controller or "go-to" person. He had been at BC for almost ten years and his knowledge of the company and the other employees was critical in making the researchers being perceived as "insiders" and members of the team (Dumay 2010).

Data were collected through a number of methods. Over the two years of the project the research team frequently visited BC and qualitative data were gathered through interviews,

observation, focus groups, company documents and participation in management meetings (Denzin and Lincoln 2008, Yin 2008). However, in contrast with non-interventionist approaches, the team of academics were here not mere observers. Their role was to "act on that situation in concert with the host organization, observes process and outcome, and analyses findings in view of the relevant literature" (Jönsson and Lukka 2006, p.4).

4. Results

The project started with the analysis of BC's main processes. Despite not being the type of interventionist role the researchers had in mind, the GM wanted to take advantage of the experience of the researchers in this field to investigate potential sources of inefficiencies. The GM was very much convinced that the solution of the issues perceived and shared by a number of employees could bring significant time and money savings [2]. The initial investigation involved the mapping and costing of BC's main processes: demand development and bids preparation, management of the bids acquired and other support activities, such as financial planning, treasury management, billing, recordkeeping. This analysis followed the principles of Process Activity Mapping (PAM, Morrow and Hazell 1992) and was based at first on interviews with the GM, the Head of Sales and the Head of the Administrative department to understand the main activities performed and the employees involved. Then, each activity was "micro-mapped" through interviews with each employee of the target processes. The cost of each micro-activity was then calculated by multiplying the hourly wage of each employee by the time needed to perform the micro-activity and an analysis of the efficiency of the activity was performed. Twenty employees operating in the sales, bids and administrative department were involved in this phase, which entailed approximately 80 hours of observation. The analysis did find and estimate a number of issues in the current process configuration due to poor IT systems, redundancies, wrong procedures and routines. However, despite representing important issues to deal with, the solution of these inefficiencies could only marginally impact BC's performance. Even in the event of saving the whole amount emerged from the analysis, BC would still be unable to regain the past levels of profitability.

Also on the basis of these first results, the research team raised the need for a strategy-focused and data-based approach to develop following the BPA-framework. The work of mapping the processes was not useless for this target. It had provided deep insights of the organisation, the activities performed and the data available. The observations of the huge amount of documents, files, software and reports had led to the strong belief that the BC could be the proper site to test the BPA-framework due to the significant amount of data available. Yet, after spending many hours with the employees and the go-to-person for mapping the processes, the research team was appreciated as experienced professionals and experts. This was a first relevant pro of the interventionist approach compared to a traditional case study (Jonsson and Lukka 2006).

The first step of the framework– the analysis of the business strategy- was performed by collecting data through interviews with the GM and some managers of the cooperatives members of the BC and by analysing some archival data related to the financial statements and sales information of the last five years. The role of "insiders", participating to a project promoted by the company played a fundamental role to obtain the full access to the data and to the people to interview. This is a relevant feature of interventionist research (Van de Ven

[2] In interventionist research, it is common for the researcher to perform some analyses or tasks non included in the main research project in order to obtain the commitment of the organization to the research project (Suomala et al. 2014, p. 307).

and Johnson 2006). More specifically, interventionist research is not only "grounded in data", but also "grounded in action", allowing the researcher to observe the managers and employees when they take their decisions or do their job (Jonsson and Lukka 2007, p. 375; Atkinson and Shaffir 1998).

A meeting with the GM was held to discuss the data collected. The strategy of the company was focused to a clear target: to increase the number of bids won without increasing the operating costs. The company had a group of employees with high experience and most of them were members of the cooperative. The reduction of the workforce to increase the profitability keeping constant the revenues was not a strategic option. This point was in conflict with the initial idea to analyse and increase the efficiency of the processes. The only remaining strategic option was to increase the number of bids won given the actual number of employees. The analysis should then be focused on the factors affecting the capability of winning the tenders.

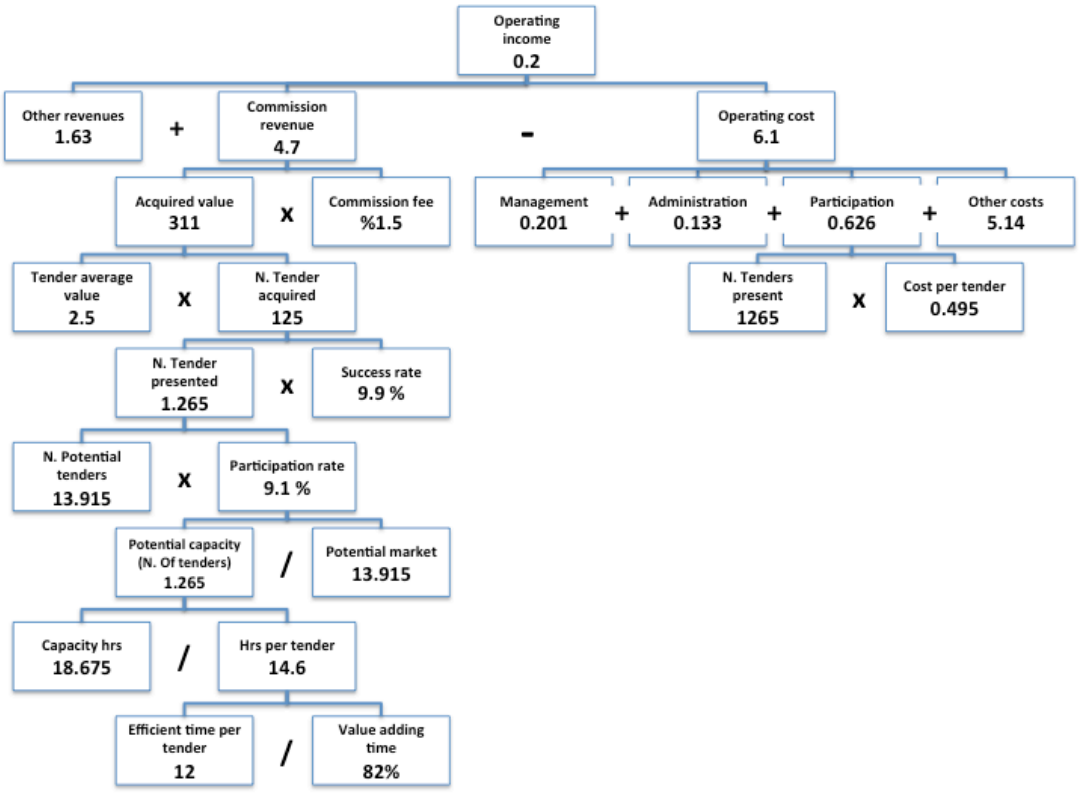
The result was the summarized in the following statement by the research team:

"Almost all the costs of the company (mainly due to wages) are fixed, while the revenues are highly variable, as they are calculated as a percentage of the works acquired for the cooperatives, plus some fees paid for managing the relationship with the customer. Thus, being the cost fixed, the higher the amount of the works acquired, the higher the profit, with a huge leverage effect of the revenues on the profit".

This statement may appear quite obvious at a first sight, but it proved to useful in shifting the focus of the PMS: from costs and efficiency of the processes (the first issue raised by the GM) to revenues and the capability of acquiring works for the building cooperatives. It was not easy to explain this change of focus from costs to revenues to the organization and particularly to the controller. He came from a 25 years long experience as a controller in several organizations and his work had always been focused on cost accounting and control. In his opinion performance measurement should be naturally focused on costs, while revenues analysis was *"something funny done by the marketing people"*. Before moving forward, the research team decided to present and discuss with the controller some simulations and analyses which showed the higher impact of an increase of the acquisition ratio (the percentage of won tenders on the total amount of bids, AR from now), compared to the cost reduction achievable with increased efficiency. This step was important to keep the commitment of the controller that, being the go-to person had a fundamental role for the data collection and interpretation (Dumay 2010).

Then the research team, starting from some aggregated data provided by the controller, broke down the profitability of the company to explain the main drivers affecting the revenues and the costs.

Figure 1: the financial performance map of the company



The final result, represented in Figure 1, clearly shows how the financial performance of the company depends not only on its efficiency (the hours needed to participate to each tender), but also on the potential market (external data provided by the GM), the total capacity available (the total number of hours available) and the AR (that lied under 10%). The increase in revenues could then be generated in different ways: by increasing the Capacity (e.g. hiring people), by increasing the efficiency (e.g. reducing the time needed for each tender) or by selecting and managing the different tenders in order to increase the amount of revenues generated (e.g. higher average dimension of the tenders or higher AR).

This was a first big picture of the situation, but it provided relevant insights on the way the performance of BC is generated and on its main drivers. **It also supported the following step of the framework, the definition of the key questions related to critical performance variables (diagnostic control) and strategic uncertainties (interactive control).** The GM organized a meeting with the research team, the controller and some of the project owners responsible for the management of the bids. The focus group was aimed to define the questions to answer for understanding the root causes of the performance and the main potential risks. The interaction between the managers and the researchers helped in understanding new ways of looking at the crucial factors affecting the performance and was very appreciated by the company. The capability to respond to the pressure of a demanding organization that aims to solve its problems and respond to its issues is another crucial element of a well-developed interventionist research (Suomala et al. 2014).

The main questions raised at the end of the focus group were:

1. What is the AR in the different kind of tenders (big versus little; within the geographical region of the BC vs. out of the region or out of the country; related to public or private customers, etc.)?

2. Considering that a high AR in little tenders can be less profitable that a low AR obtained in bigger tenders, what is the measure we should focus on to understand the effectiveness of our performance?

3. What are the drivers affecting the capability to acquire the bids? Are they related to the features of the tenders (geographical area, size, etc.) or to the organization (project owner, software availability, etc.)?

4. What is the effect on the profitability of the company of a change in each of these factors? As a consequence, which of them are more risky for the company?

5. Which specific kind of tenders we should focus on to maximize our financial performance?

As easily understandable, the five questions show a growing level of complexity, from merely descriptive analyses (different AR in different clusters of tenders), to a deeper understanding of the performance (the definition of a measure able to capture the essence of the performance), to analyses targeted to real performance management actions (what affects performance, which tenders to focus on, which project owners to choose). During the focus group, some issues emerged when the question about the performance of the project owners was raised. While it was admitted that some of them were more effective in some kind of tenders and less in others, there was resistance on measuring this aspect. In their opinion the performance of the project owners could be affected by many contingent factors (issues on specific bids, the financial problems of the customers, particular payment conditions, etc.). The research team and the GM spent quite some time to clarify that the analysis was aimed to better focus the effort of the company on the most profitable businesses and not to evaluate (or, even worse, reward) the project managers. An interventionist research project directly affects the real life of the people, in this case providing a new PMS. In so doing, it can generate adverse behaviour, from people that do not want to change (Dumay 2010).

Then **the following step of the framework, the collection of the data for the analysis, was realized**.

The previous activities performed had provided very useful information to support the data collection. The final target was to understand the best way to measure the performance, the factors affecting it and the specific features of different kind of bids. The research team began the analysis during the focus group with the GM and the project owners, trying to understand the most relevant drivers of the capability of winning the bids. Some common factors emerged. All the people involved agreed that different tenders had very different features and critical factors. The distinctive feature of the use of BPA for interactive control is that there is not an ex-ante selection of the data. Here, the objective is to “let the data speak” about the drivers of performance. As a consequence, the research team decided to collect all the data available on all the tenders of the last 5 years. At this point a number of issues emerged. The data were not stored in the same database. Some information was unstructured and recorded on Excel and Access files provided by the sales department (all the bids to which the company had participated, included the lost ones, the project manager in charge for the job, the potential revenues, the name of the customer). Some other information were provided by the accounting department (only for the won bids the detailed data of the customer, included the geographical area, the specific classification of the job, the payment conditions). Finally, the Department responsible for managing the bids provided a database including the number of hours needed for managing each bid (won or lost). A huge work had to be done, particularly on less reliable commercial information, to assess the data, evaluate mistakes or missing information, searching external databases to integrate the internal data when possible. The research team was used to deal with partial information or incomplete or partially reliable databases because of its long experience in academic research. Nevertheless this phase absorbed a significant amount of time and efforts.

Once data were collected, the research team began **to design and develop the analytical methods** (step 4 of the model). This phase of the analysis, as well as the previous one, was highly favoured by the experience on quantitative analysis of some of the members of the research group. First of all some descriptive analysis (mainly frequencies, crosstabs, correlations and graphical analyses) were run to explore the performance measures, the distributions of these variables and the relationship among the potential drivers and the final performance. The first key question about the main performance measure to analyse was discussed with the GM, the managers and the project owners. Initially they highlighted that the AR should be the target of the analysis. Then, the GM pointed out that two other relevant variables were the turnover generated by each bid and the amount of time needed to manage the job. In the end, a measure of performance was defined as the revenue generated by each hour of work needed (Revenue Per Hour, RPH). The value was obviously equal to zero for the lost bids, while equal to the ratio between the revenues and the hours needed for managing the job for the won bids. This was the first time the company clearly stated its main target, linking the performance to a specific measure.

The first descriptive analyses shows very different performances linked to: (1) geographical factors (the RPH in the region were the company was headquartered was more than double than outside it), (2) the size of the bid (the RPH of big jobs was 45% higher than for little ones), and (3) different customers (the RPH of jobs with private customers was 30% higher than with Public Administration). Moreover, it presented very different performances of the project managers in different kind of bids. On the basis of these first descriptive analyses, the research team was able to select the analytical methods and to define the statistical models for the analysis.

First of all a ***cluster analysis*** was conducted. Here, the dimensions resulted as relevant from the first descriptive analyses were used as variables of the clustering procedures (size of the bid, geographical area, specific kind of bid, private/public customer, RPH, win ratio). The analysis, conducted through a hierarchical clustering method, provided the evidence of three very different groups of bids with completely different characteristics and different performances. The first cluster was made of big jobs for Local Public Administrations within the region of the company. This was the initial business of the company and it presented a very high AR and an even higher RPH compared to the other clusters. The second group was made of middle-size jobs for foreign customers. In this group the AR was lower than 5%, even if the effort was quite high (more than 15% of the total PM hours were employed for this kind of tenders). Finally, the third group was mainly made of very little jobs for private customers. This cluster had a good AR (over 16%), but an under-the-average RPH, because the jobs were quite complex to manage compared to their limited size.

Second, a ***logistic regression*** was run. The success of the bid represented the dependent variable and a series of different dimensions were used as independent variables (the specific project owner, the customer, the specific activity to perform, the geographical area). Then, the same model was replicated for each of the three clusters emerged at the end of the cluster analysis. The result was very interesting, showing a statistically relevant role of all the variables in affecting the outcome of the bid. Yet, it provided a model able to predict the probability of success for each cluster with a small margin of error. Moreover, the analysis helped in understanding the specific project owner to select for each kind of bid.

Finally a ***multivariate regression*** was run using the same independent variables, but defining RPH as the dependent one. This model, focused on the main performance measure of the company, allowed to understand the following: (1) which kind of bids to focus on, (2) which rank of priority to establish and (3) which revenues to forecast for a given set of bids to participate.

On the whole, the results of the analysis provided the basis for: (1) selecting the more profitable bids to participate; (2) forecasting the potential revenues of a given set of bids for a given time (for instance a quarter, a semester or a year), also providing a measure of the potential error; (3) selecting of the most effective project owner for a given bid to manage, (4) understand the impact on performance of a change of each relevant drivers (risk management).

The GM was very satisfied by the result, and commented:

"We already knew some of the things emerged from the analysis, but we ignored some other results and most of all we couldn't express our beliefs with numbers so far. The potential usefulness of BPA is twofold in my opinion. First, they help in making decisions and second they could be the basis of the new performance management system. Now we know the variables to measures (AR and RPH), the most effective classification of the bids (the three clusters emerged from the cluster analysis), the drivers of the performance (the size and geographical area of the bid and the specific customer), and the impact of the project owners on the performance. Now we have to translate this knowledge in plans, targets, measures and controls.

With the last part of his sentence, the GM was anticipating the last step of the BPA framework, **the definition of the performance management system.** Few days after the final presentation of the analysis he created a group for defining the performance management system based on the selected BPAs. The controller, the Head of the Sales Department and the Head of the project owners attended a short education program on statistical analysis for better understanding the outcomes of the analysis. At the moment the performance management system is under construction and should be operative in a time length of about 6 months.

5. Discussion and conclusions

This paper explores the role of Big Data and business analytics for performance measurement purposes. Building on the notion of Simons of diagnostic and interactive control (1995) it theorises the integration of Big Data and business analytics within performance management systems for strategic control. It does so by developing a framework which indicates a number of issues to be taken into consideration when designing and implementing business performance analytics (BPA). To gain a more in depth understanding of the potential and limits of BPA, the framework was also empirically tested by adopting a "strong" interventionist approach.

The case study developed in a consortium of the building industry has shown the relevant potential of the BPA framework for supporting and operationalizing the concept of diagnostic and interactive control.

The starting situation of the company presented many of the limits commonly associated by the literature to the use of information systems for performance management purposes. Following the main points highlighted by Klatt et al. (2011):

- *information overload*. Within the BC many different databases included a huge amount of information about the different jobs. Commercial data were collected by the Sales Department, accounting information by the Administrative Department and operational data by the Organizational Unit responsible for managing the tenders. But all this information were not categorized, coordinated in a system, and were often incomplete

and/or unreliable. This is one of the most relevant boundary for an effective use of the data for PMS purposes (Nudurupati et al. 2011);

- *the absence of measured casual interdependences.* Some causal relationships were hypothesized, but the company had never performed any analysis to understand and quantify the relationships about the different performance drivers (the different features of the tender and the project owner responsible for the job) and the final performance. Again, the definition of performance measures not linked by clear and quantified causal relationships is reported by the literature as one of the most critical limits of the PMS (Brignall 2002);
- *the lack of an holist view of the organization.* This is probably the most critical point of the PMS operating in the BC. The information was fragmented, collected for separately measuring the performance of each Department and not included in a whole PMS model able to describe the way the performance was generated. This lack of understanding of the performance model had led to focus the attention on cost reduction and efficiency, instead of effectiveness improvement through the increase of the won tenders. There was a huge lag between the strategy, the business model and the way the data were used for performance management purposes (Lucey 2005). The BC did not even analyse a clear measure of performance and the system, that was purely diagnostic in nature, did not support a better understanding of the performance model.

The context was ideal for developing an new approach to control, able to focus on the critical performance variables (diagnostic control) and to stimulate learning and research of new ways for performance management (interactive control), because the strategy and the performance model were almost undefined and very poorly structured. The application of the BPA framework at the Building Consortium provided some encouraging results about the support that BPAs can provide to the translation of the theoretical concepts of diagnostic and interactive control in real actions to take to increase the strategic relevance of the PMS.

First, coherently with the framework of Ferreira and Otley (2009) all the procedure started from the descriptive and numeric analysis of the strategy and the business model. Doing that, it was immediately clear the prevalent role of effectiveness enhancement compared to efficiency improvement in affecting the whole performance. As stated by the dominant literature on performance management, the link between the PMS and the strategy is a very critical point (Chenhall 2005). This was a very important step, because it supports the definition of the key questions and the data to collect to understand the critical performance variables and the strategic uncertainties. The BC, involving the research team as well, has spent a lot of time collecting data and analysing the efficiency of the processes, while the key questions and consequently the data to collect were related to the capability of acquiring jobs for the building cooperatives. The support of BPA for diagnostic and interactive control is fully developed when the analytical methods are applied to the data, but the previous steps are fundamental to avoid the frequently reported issue of huge amount of data and analyses without a real contribution to performance management, because not linked to the strategic drivers of performance (Grant et al. 2006). Once the key questions are clearly stated and the data identified, collected, assessed and revised, the development of the statistical and mathematical analyses at the core of the BPA framework is just a technical exercise, were the analytical capabilities are applied to a well-defined research question. In the case study the

analyses performed were able to support all the different aims of the analytical performance evaluation (Gartner Report 2012):

a) *descriptive*: the first analyses performed (frequencies, crosstabs, graphical distributions) had a general and descriptive target;

b) *diagnostic*: the cluster analysis and the regressions helped in understanding what happened in the past and what were the main drivers of the performance;

c) *predictive*: once defined the regression model it can be applied to a given set of potential jobs to determine the expected revenues and the potential error of the estimation. Moreover, it helped in investigating the strategic uncertainties analysing the impact on performance of different competitive scenarios;

d) *prescriptive:* the analyses support the decisions to make, for example which tenders to focus on or which project manager to choose for a new tender or which competences and expertise to develop to increase the performance of the project owners on different categories of tenders.

The final step of the BPA model, the definition of the performance management system, was not fully developed in the case study, nevertheless it play a crucial role in generating the diagnostic and interactive effect of the control system. For the diagnostic control system it is evident that the different steps of the performance management system (to define the targets, to measure the results, to report them to the managers and operators and to analyse the variances to the targets) are crucial for the final effectiveness of the system. As for interactive control, if we look at the four characteristics pointed out by Simons (1995) (-the data generating the agenda of the top management – attention to the information by the managers at all levels – face to face meetings to discuss the data provided by the system – the catalyst role of the system for the continual challenge and debate of the data) we can easily see that they mainly deal with the way the data are managed and the system is continually refreshed and kept coherent with the strategy and the business model of the company. With a sort of a paradox we can say that the assessment of the strategic critical factors and the development of the analytical tools are given for grant, such as mechanical and repetitive steps, while the most critical part of interactive control is related to the way the system is managed and continuously rejuvenated.

The case study provided also some first, but very useful insights on the most critical aspects to focus on when performing the BPA framework here presented. First of all there is a huge communication issue when the model is applied to a real organization. Firstly, because most of the people involved in the system are not necessarily used to manage statistical and mathematical tools or concepts like the ones involved in the BPA framework. Second, the BPA framework can completely overturn the traditional way of analysing the performance by managers and employees. As a consequence, some educational projects should go along with the development of the project and each tool and analysis should be developed in the easiest possible way. During the research, one of the main obstacles to overtake was the difficulty of the controller and the project managers to understand this new way of looking at the BC performance and the research team spent a huge amount of time with them. A perfectly designed framework is completely useless if not well understood by the people that have to manage it. Even if quite obvious, another critical point for the success of the BPA framework is the volume, completeness and reliability of the data. With poor data you can obtain only

poor results. The assessment of the available data, the integration of missing values (if possible), the correction of errors play a crucial role in the whole model.

We believe our work delivers a number of contributions both theoretically and practically.

First, it develops a framework which theorizes the use of data and business analytics for performance management purposes (BPA). By identifying a series of phases in the development of BPA, the framework is intended to help the conduct of research that explores the potential of data (internal or external, structured or unstructured) and analytical tools in the design and use of PMS. In this sense it could be seen as an extension of Simons' lever of control framewrok (1995) whereby the use of PMS and information systems are blended together to promote the diagnostic and interactive control of strategy. In so doing our work delivers a second important contribution to the emerging stream of literature regarding the use of PMS for diagnostic and interactive control. In particular, it helps operationalising the ambiguous notion of interactive control (Tessier and Otley 2012) by clarifying how BPA can be employed to analyse strategic uncertainties and in better focus the diagnostic control on the most critical performance variables. In our view, data represent the inputs of the organisational performance model and not simply its output, as hypothesised by the traditional control feedback mechanism. In other words, data are not primarily used to understand past results but to identify the drivers of future performance and the most relevant risks. The BPA framework sheds light on the potential role of different types of analytics: (1) descriptive/exploratory - to understand the performance determinants), (2) predictive - to anticipate future performance on the basis of the key performance drivers previously identified, (3) prescriptive – to recommend specific actions when certain conditions are satisfied. This type of analysis also allows for the evaluation of the risk associated to a certain performance. Indeed, the use of statistical tools consents the computation of the estimated level of error and variance of the model of performance. In summary, the proposed BPA framework contributes to clarify the potential strategic role of Big Data and business analytics for interactive control and promotes the use of quantitative information to support the management of organisational performance.

By adopting a "strong" interventionist approach we also contribute to an emerging stream of literature in the management accounting field (Lukka etc) and we address the call for exploring further the potential of this approach for practice-relevant management accounting theory (Lukka 2014 A&buss research). In this sense our work provides a detailed account of the interventionist process and highlights the benefits and challenges of the "insider" role played by the researcher.

Our work has also several managerial implications. At first it stresses the pivotal role of linking BPA to the company's strategy and business model. This is considered a necessary condition for any BPA to be able to play a strategic role. The leitmotiv of practice-oriented literature is that Big Data and business analytics will transform organizations and improve performance. While we agree on the great potential of data and sophisticated tools we take a critical perspective on the possibility that this will work without linking them to the strategy and its value drivers. Like more conventional approaches to performance management, the purpose is to identify and monitor the critical performance variables not simply adding data and/or statistics (Silvi et al 2011). Secondly, the framework requires managers to reflect on the quality of data. Before developing any BPA, a thorough evaluation of the completeness,

comprehensiveness and reliability of data is critical (Bhimani and Willcocks 2014). If anything, data richness and the presence of structured and unstructured data will expand the issues affecting smaller datasets (e.g. coherency, mistakes, missing information). In other words, inherent biases in data collection and processing risk producing a garbage in/garbage out effect that will compromise manager's trust in the analysis and results. Thirdly, engaging with a more data-driven interactive control is likely to create cultural and competences issues. As emerged from the case study, accountants tend to be more used to the sequential logic of the feedback mechanism, even when applied to non-financial indicators. Developing a control model which derives key strategic variables from data requires a significantly different mind-set and skills. Thus, staff training and skills development may be as important as the data and statistics employed.

This paper is based on a single case study and this represents an obvious but important limitation. When drawing conclusions, it must be therefore considered that generalisation is not possible. Yet, this is an interventionist research work and the specific measurement model and results were influenced by the researchers' view. However, a thorough explanation of the BPA framework and a detailed account of the research process are provided to allow other researchers to test the propositions advocated in the paper.

Our work opens up a number of avenues for future research. First, further investigation of how the BPA framework can promote diagnostic and interactive control is required. For instance, the study of environments with different levels of dynamisms as well as contexts where external data may play a more significant role could represent interesting options. Secondly, while our framework focuses on the role of BPA for strategic control, we are conscious that these sub-systems should be considered in relation to the other levers of control (Simons 1995). Thus, and in line with recent research contributions (Mundy, 2010), the role of BPA in creating dynamic tensions and developing unique organisational capabilities could be investigated. Thirdly, when it comes to choose which variables to control, we expect that the use of a data-driven method would produce a more "objective" and selective approach. In this sense, it would be worth exploring if and how BPA influence the design of PMS compared to the add-on effect that often characterises the development of comprehensive PMS (Silvi et al., 2014). Finally, despite adopting a holistic interpretation of performance management, our current work only touches upon the organisational issues associated with the implementation of the BPA framework. BPA require a blend of different competencies and are "inter-departmental" in nature. Therefore questions like the "ownership" of BPA or the evolution (or regression) of the role of the accountant offer wide scope for future research.

References

Amit, R., Zott, C., 2002. Value drivers of e-commerce business models. In Hitt, M.A., Amit, R., Lucier, C., Nixon, R.D. (Eds.), Creating value: Winners in the new business environment. Blackwell, Oxford, UK, pp. 15-47.

Anderson, S.W., Widener, S.K., 2007. Doing Quantitative Field Research in Management Accounting. In: Chapman, C.S., Hopwood, A.G., Shields, M.D. (Eds.), Handbook of Management Accounting Research. Elsevier Ltd., Amsterdam, pp. 319-341.

Argyris, C., Putnam, R., McLain Smith, D., 1985. Action Science. Jossey-Bass, San Francisco.

Atkinson, A. A., Shaffir, W., 1998. Standards for field research in management accounting. Journal of management accounting research, 10, 41.

Atkinson, A.A., Waterhouse, J.H., Wells, R.B.. 1997. A stakeholder approach to strategic performance measurement. MIT Sloan Management Review, 38(3), 25.

Beaubien, L., 2012. Technology, change, and management control: a temporal perspective. Accounting, Auditing & Accountability Journal, 26(1), 48-74.

Berg, B.L., Lune, H., 2012. Qualitative Research Methods for the Social Sciences, eight ed. Pearson, Edinburgh.

Berry, A.J., Coad, A.F., Harris, E.P., Otley, D.T., Stringer, C., 2009. Emerging themes in management control: A review of recent literature. The British Accounting Review, 41, 2-20.

Bhimani, A., Willcocks, L., 2014. Digitisation, "Big Data" and the transformation of accounting information. Accounting and Business Research, 44(4), 469-490.

Bisbe, J., Malagueño, R., 2009. The choice of interactive control systems under different innovation management modes. European Accounting Review,18(2), 371-405.

Bisbe, J., Batista-Foguet, J.M., Chenhall, R.H., 2007. Defining management accounting constructs: a methodological note on the risks of conceptual misspecification. Accounting, Organizations and Society, 32, 789-820.

Bisbe, J., Malagueño, R., 2012. Using strategic performance measurement systems for strategy formulation: Does it work in dynamic environments?. Management Accounting Research, 23(4), 296-311.

Bititci, U. S., Mendibil, K., Nudurupati, S., Garengo, P., Turner, T., 2006. Dynamics of performance measurement and organisational culture.International Journal of Operations & Production Management, 26(12), 1325-1350.

Bititci, U., Garengo, P., Doerfler V., Nudurupati, S., 2012. Performance Measurement: Challenges for Tomorrow. International Journal of Management Reviews, 14, 305-327.

Bourne, M., Mills, J., Wilcox, M., Neely, A., Platts, K., 2000. Designing, implementing and updating performance measurement systems. International journal of operations & production management, 20(7), 754-771.

Brignall, S., 2002. The Unbalanced Scorecard: A Social and Environmental Critique. In: Neely, A., Walters, R.A. (Eds.), Performance Measurement and Management: Research and Action. Performance Measurement Association, Boston, pp. 85-92.

Broadbent, J., Laughlin, R., 2009. Performance management systems: A conceptual model. Management Accounting Research, 20(4), 283-295.

Burns, J., Vaivio, J., 2001. Management accounting change, Management Accounting Research, 12, 389-402.

Campbell, D., Datar, S., Kulp, S. C., Narayanan, V. G. ,2002. Using the balanced scorecard as a control system for monitoring and revising corporate strategy.

Chapman, C.S., Kihn, L.A., 2009. Information system integration, enabling control and performance. Accounting, Organisations and Society, 34 (2), 151-169.

Chenhall, R. H. , 2005. Integrative strategic performance measurement systems, strategic alignment of manufacturing, learning and strategic outcomes: an exploratory study. Accounting, Organizations and Society, 30(5), 395-422.

Chenhall, R.H., 2003. Management control systems design within its organizational context: findings from contingency-based research and directions for the future. Accounting, Organizations and Society, 28. 127-168.

Chenhall, R.H., 2005. Integrative strategic performance measurement systems, strategic alignment of manufacturing, learning and strategic outcomes: an exploratory study. Accounting, Organizations and Society, 30 (5), 395-422.

CIMA (Chartered Institute of Management Accountants), 2014. Big Data. Readying business for the big data revolution. http://www.cgma.org/Resources/Reports/DownloadableDocuments/CGMA-briefing-big-data.pdf. Accessed 15th July 2015.

Davenport, T. H., & Prusak, L., 1997. Information ecology: Mastering the information and knowledge environment. Oxford University Press.

Davenport, T., Harris, J.G., 2007. Competing on Analytics. Harvard Business Press, Boston.

Davenport, T.H., Harris, J.G., Morison, R., 2010. Analytics at Work: Smarter Decisions. Better Results, Harvard Business Press, Boston.

De Geuser, F., Mooraj, S., Oyon, D., 2009. Does the balanced scorecard add value? Empirical evidence on its effect on performance. European Accounting Review, 18(1), 93-122.

Denzin, N. K., Lincoln, Y. S. , 2008. Collecting and interpreting qualitative materials (Vol. 3). Sage.

Dixon, J.R., Nanni, A.J., Vollmann, T.E., 1990. The New Performance Challenge. Measuring Operations for World Class Competition, Business One Irwin, Illinois.

Dumay, J. C., 2010. A critical reflective discourse of an interventionist research project. Qualitative Research in Accounting & Management, 7(1), 46-70.

Eisenhardt, K.M., 1989. Building Theories from Case Study Research. Academy of Management Review, 14 (4), 532-550.

Epstein, M., Manzoni, J.F., 1998. Implementing Corporate Strategy: From Tableaux de Bord to Balanced Scorecards. European Management Journal, 16, 190-203.

Ferreira, A., 2002. Management accounting and control systems design and use: an exploratory study in Portugal. PhD Thesis. Department of Accounting and Finance, Lancaster University.

Ferreira, A., Otley, D., 2009. The design and use of performance management systems: An extended framework for analysis. Management Accounting Research, 20, 263-282.

Gartner Report, 2012. Forecast: Enterprise software markets. Worldwide, 2011-2016, 4Q12 Update. Accessed on March 18, 2013 through http://www.gartner.com/resId= 2054422

Gimbert, X., Bisbe, J., Mendoza, X., 2010. The Role of Performance Measurement Systems in Strategy Formulation Processes. Long Range Planning, 43, 477-497.

Grant, D., Hall, R., Wailes, N., Wright, C., 2006. The false promise of technological determinism: the case of enterprise resource planning systems. New Technology, Work and Employment, 21 (1), 2-15.

Hoque, Z., James, W., 2000. Linking balanced scorecard measures to size and market factors: impact on organizational performance. Journal of management accounting research, 12(1), 1-17.

Hyvönen, J., 2007. Strategy, performance measurement techniques and information technology of the firm and their links to organisational performance. Management Accounting Research, 18 (3), 343-366.

IFAC, 2011. Predictive Business Analytics: Improving Business Performance with Forward-looking Measures.

Ittner, C.D., Larcker D.F., 1998. Are Non Financial Measures Leading Indicators of Financial Performance? An Analysis of Customer Satisfaction. Journal of Accounting Research, 36, 1-35.

Ittner, C.D., Larcker, D.F., 2005. Moving from strategic measurement to strategic data analysis. In Chapman, C.S. (Ed.), Controlling strategy: Management, accounting, and performance measurement. Oxford University Press, New York, pp. 86-105.

Ittner, C.D., Larcker, D.F., Randall, R., 2003. Performance implications of strategic performance measurement in financial services firms. Accounting, Organizations and Society, 28, 715-741.

Jönsson, S., Lukka, K., 2006. There and Back Again: Doing Interventionist Research in Management Accounting. In: Chapman, C.S., Hopwood, A.G., Shields, M.D. (Eds.), Handbook of Management Accounting Research. Elsevier Ltd., Amsterdam, pp. 373-397.

Kaplan, R. S., Norton, D. P., 2008. Mastering the management system.Harvard business review, 86(1), 62.

Kaplan, R.S., Norton, D.P., 1992. The Balanced Scorecard – Measures that Drive Performance. Harvard Business Review, 70, 71-79.

Kasanen, E., Lukka, K., Siitonen, A., 1993. The constructive approach in management accounting research. Journal of Management Accounting Research, 5, 241-264.

Klatt, T., Schläfke, M., and Möller, K., 2011. Integrating business analytics into strategic planning for better performance. Journal of business strategy, 32(6), 30-39.

Kominis, G., Dudau, A.I., 2012. Time for interactive control systems in the public sector? The case of the Every Child Matters policy change in England. Management Accounting Research, 23(2), 142-155.

Labro, E., Tuomela, T.S., 2003. On bringing more action into management accounting research: Process considerations based on two construc- tive case studies. European Accounting Review, 12 (3), 409–442.

Lucey, T. (2005). Management information systems. Cengage Learning EMEA.

Lynch, R.L., Cross, K.F., 1991. Measure Up! Yardstick For Continuous Improvement. Blackwell, Cambridge, MA.

Lynch, R.L., Cross, K.F., 1995. Measure up!: how to measure corporate performance. Blackwell, Cambridge, MA.

Manyika, J., Chui, M., Brown, B., Bughin, J., Dobbs, R., Roxburgh, C., & Byers, A. H. (2011). Big data: The next frontier for innovation, competition, and productivity. McKinsey Global Institute, http://www.mckinsey.com/insights/business_technology/big_data_the_next_frontier_for_innovation, accessed 13th July 2015.

Marchant, M., Raymond, L., 2008. Researching Performance Measurement systems – An information systems perspective. International Journal of Operations and Production Management, 28(7), 663-686.

May, T., 2009. The new know: Innovation powered by Analytics. Wiley & Sons Inc., New Jersey.

Melnyk, S. A., Bititci, U., Platts, K., Tobias, J., Andersen, B., 2014. Is performance measurement and management fit for the future?. Management Accounting Research, 25(2), 173-186.

Micheli, P., Manzoni, J.F., 2010. Strategic Performance Measurement: Benefits, Limitations and Paradoxes. Long Range Planning, 43, 465-476.

Mintzberg, H., 1978. Patterns of strategy formulation. Management Science, 24, 934-948.

Morris, M., Schindehutte, M., Allen, J., 2005. The entrepreneur's business model: Toward a unified perspective. Journal of Business Research, 58, 726-35.

Morrow M., Hazell M., 1992. Activity Mapping for Business Process Redesign. Management Accounting, February, 36-38.

Mundy, J. , 2010. Creating dynamic tensions through a balanced use of management control systems. Accounting, Organizations and society, 35(5), 499-523.

Neely, A., 1999. The performance measurement revolution: why now and what next?. International Journal of Operations & Production Management, 19 (2), 205-28.

Norreklit, H., 2000. The Balance on the Balanced Scorecard. A critical analysis of Its Assumptions. Management Accounting Research, 11, 65-88.

Nudurupaty, S.S., Bititci, U.S., Kumar, V., Chan, F.T.S., 2011. State of the art literature review on performance measurement. Computers and Industrial Engineering, 60, 279-290.

Orlikowski, W. J., 2000. Managing use not technology: a view from the trenches. Mastering Information Management. London: Prentice-Hall.

Otley, D., 1980. The contingency theory of management accounting: achievement and prognosis. Accounting, Organizations and Society, 5, 413-428.

Parker, L.D., 2012.Qualitative Management Accounting Research: Assessing deliverables and relevance. Critical Perspectives on Accounting, 23 (1), 54-70.

Prahalad, C. K., Krishnan, M. S., 2002. The dynamic synchronization of strategy and information technology. Sloan Management Review, 43(4).

Rigby, D., Bilodeau, B., 2009. Management tools and trends 2009. Bain & Company.

Sahay, B.S., Ranjan, J., 2008. Real time business intelligence in supply chain analytics. Information Management and Computer Security, 16 (1), 28-48.

Scapens, R.W., 1990. Researching Management Accounting Practice: the Role of Case Study Methods. British Accounting Review 22, 259-281.

Schläfke, M., Silvi, R., & Möller, K., 2012. A framework for business analytics in performance management. International Journal of Productivity and Performance Management, 62(1), 110-122.

Seufert, A., Schiefer, J., 2005. Enhanced Business Intelligence – Supporting Business Processes with Real-Time Business Analytics. Available on http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=1508391&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D1508391

Silvi, R., Bartolini, M., Raffoni, A., & Visani, F. , 2015. The practice of strategic performance measurement systems: Models, drivers and information effectiveness. International Journal of Productivity and Performance Management, 64(2), 194-227.

Silvi, R., Bartolini, M., Raffoni, A., Visani, F., 2012. Business Performance Analytics: level of adoption and support provided to Performance Measurement Systems. Management Control, Special Issue, 3, 117-142.

Simons, R., 1995. Levers of control. How Managers Use Innovative Control Systems to Drive Strategic Renewal. Harvard Business School Press, Boston.

Smith, P.C., Goddard, M., 2002. Performance management and operational research: a marriage made in heaven? Journal of the Operational Research Society, 53 (3), 247-255.

Stubbs, E., 2011. The value of Business Analytics. Wiley & Sons Inc., New Jersey.

Suomala, P., Lyly-Yrjänäinen, J., & Lukka, K., 2014. Battlefield around interventions: A reflective analysis of conducting interventionist research in management accounting. Management Accounting Research, 25(4), 304-314.

Suomala, P., Yrjänäinen, J.L., Lukka, K., 2014. Battlefield around interventions: A reflective analysis of conducting interventionist research in management accounting. Management Accounting Research, 25, 304-314.

Syed, A., Gillela, K., Venugopal, C., 2013. The future revolution on Big Data. International Journal of Advanced Research in Computer and Communication Engineering, 2(6), 2446-2451.

Tapscott, D., Lowy, A., Ticoll, D., 2000. Digital capital: Harnessing the power of business webs. Thunderbird International Business Review, 44 (1), 5-23.

Tessier, S., Otley, D., 2012. A conceptual development of Simons' Levers of Control framework. Management Accounting Research, 23(3), 171-185.

Townley, B., Cooper, D. J., Oakes, L., 2003. Performance measures and the rationalization of organizations. Organization Studies, 24(7), 1045-1071.

Trkman, P., McCormack, K., Valadares de Oliveira, M.P., Bronzo Ladeira, M., 2010. The impact of business analytics on supply chain performance. Decision Support Systems, doi:10.1016/j.dss.2010.03.007.

Tuomela, T.S., 2005. The interplay of different levers of control: a case study of introducing a new performance measurement system. Management Accounting Research, 16(3), 293-320.

Van Aken, J., 2004. Management research based on the paradigm of the design sciences: the quest for field-tested and grounded technological rules. Journal of Management Studies, 41 (2), 219–246.

Van de Ven, A. H., & Johnson, P. E., 2006. Knowledge for theory and practice. Academy of management review, 31(4), 802-821.

Van de Ven, A.H., 2007. Engaged Scholarship: A Guide for Organizational and Social Research. Oxford University Press, Oxford.

Van de Ven, A.H., Johnson, P.E., 2006. Knowledge for theory and practice. Academy Management Review, 31 (4), 802–821.

Warren, J.D., Moffitt, K.C., Byrnes, P., 2015. How Big Data will change accounting. Accounting Horizons, 29(2), 397-407.

Weill, P., Vitale, M.R., 2001. Place to space: Migrating to e-business models. Harvard Business School Press, Boston.

Yin, R.K., 2008. Case study research: design and methods, Sage Publications, Beverly Hills, CA.

Zhang, J., Yang, X., Appelbaum, D., 2015. Toward effective Big Data analysis in continuous auditing. Accounting Horizons, 29(2), 469-476.