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Performance Measurement System (PMS) in Data Centers

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Summary

Nowadays, data center industry accelerates climate change by their current consumption of energy and gas production. Global predictions that climate change may influence extreme weather conditions are making data centers to improve their performance, and become more sustainable and energy efficient. In order to educate data center business owners about the importance of data centers' becoming greener, access to appropriate tools are needed.

This study provides an overview of PMS models and elaborates in which way they can integrate sustainability within data center's corporate strategy. Furthermore, the study describes the characteristics of each model and investigates which model would be appropriate for data center's needs and what solutions it can offer to improve data center sustainability.

PMS models that are analyzed in this paper are Balanced Scorecard (BSC), Performance Prism, EFQM Excellence Model, and Activity-Based Costing (ABC), while some other performance measurement models, frameworks and techniques are mentioned in this work as well. In addition to elaborating the features of each PMS model and in which way these models incorporate sustainability within organization's corporate strategy, their systematic and critical analysis was carried out. Based on the analysis, conclusions about their advantages and disadvantages were drawn.

The findings in this paper suggest that all of the mentioned PMS models have the ability to integrate three dimensions of sustainability and offer the possibility to integrate the management of environmental and social aspects into data center's business activities. However, a common disadvantage to all these models is their inability to cover all business dimensions. Also, not all of the PMS models are able to connect performance measurement with data center's strategy and long-term objectives therefore they are rather used to assist performance measurement selection within a data center, apart from or in combination with another PMS model. Accordingly, the best possible choice for a data center among all PMS models that are analyzed in this work are the PMS such as BSC and ABC since these models are able to provide the right set of measures, and are proven to be effective in communicating measures as well as identifying causes and effects to help data center's managers, operators, and designers/engineers better understand where to apply attention in order to enhance the data center's performance.

Finally, the proposed solution in this study regarding data center's sustainability is utilization of sustainability metrics such as Power usage effectiveness (PUE), Carbon usage effectiveness (CUE) and Water usage effectiveness (WUE) – which aligned with appropriate PMS – can help IT

organizations better understand and improve sustainability of their existing data centers as well as help them to make smarter decisions on new data center deployments. Performance measurement of resources and cost optimization metrics are also one of the recommendations for maximizing operational efficiency of data centers and reducing negative impact on resources and environment.

Chapter I. Introduction

1.1. Problem description

According to former US vice president and climate activist Al Gore, the world faces "a climate crisis of unprecedented proportions," and data center industry can – and should – make a tremendous contribution towards averting-climate change disaster. Speaking at Google's "How Green Is The Internet? Summit" at the company's Mountain View headquarters, Gore reiterated his belief that global warming is real, and that its effects are already upon us. *"On a daily basis we now put 90 million tons of global-warming pollution into the thin shell of atmosphere surrounding the planet every single day,"* Gore said, adding that 20% of what humankind is currently pumping into the atmosphere will still be there 10,000 years from now (Myslewski, 2013). He reminded the Summit attendees that although the atmosphere may appear limitless, it is actually a thin layer encasing the earth. According to Gore, „our planet is running a fever," and the effects of that extra energy are resulting in extreme weather. He went to describe such recent extreme weather events as the current 500-year flood in southern Germany, storm surges in New York as a result of Hurricane Sandy that added to $110bn in climate-related US disasters in 2012, and recent floods in Pakistan that displaced 20 million people (Myslewski, 2013). *„We have to connect dots between this 90 million tons per day of global-warming pollution that we are spewing into the atmosphere as if it is a open sewer,"* he said, *„and the disruption of the climate conditions that have nurtured and made possible the flourishing of human civilization since the beginning of the first cities less than 10,000 years ago"* (Myslewski, 2013).

Experts around the world suggest that the amount of energy consumed by the world's data centers will treble in the next decade, putting an enormous strain on energy supplies and dealing a hefty blow to efforts to contain global warming (Bawden, 2016). Since data centers account for approximately 1.5-2% of world's total energy usage, there is an increased focus on sustainability initiatives and calls for greater energy efficiency (Kovach, 2015).

Data center is the brain of a company and the place where most critical processes are run (SAP Data Centre, 2017). More specific, it is a facility that contains information technology equipment including computer servers used for data processing, data storage devices and network device (Masanet, Shehabi, & Koomey, 2013). Varying from a small room with servers to vast farms with floor area of 150.000 m^2 data centers are big energy users (Vaughan, 2015). The researchers estimated that one data center could require the amount of electricity used to power nearly 180.000 homes (Walsh, Time Inc., 2013).

To put the size of this consumption into even sharper belief – the 416.2 terawatt hours of electricity the world's data centers used in 2015 was significantly higher than the UK's total consumption of about 300 terawatt hours (Bawden, 2016). Greenpeace International projected that the global demand for electricity from data centers will further increase and thereby exceed its current level by 2020 (Cook & Van Horn, 2011). As well as requiring power to run the equipment that stores and serves cloud computing and on-demand music, films and entertainment, data centers also generate a lot of heat and require a huge amount of energy to keep them cool (Vaughan, 2015). By using more energy, data centers are using more water, which in turn increases energy use even further (Madani & Khatami, 2015). According to the Uptime's Institute survey data, an average data center deployment would consume approximately 7 to 8 million gallons of water annually in order to maintain the required heat temperature (Klesner, Orr, & Stansberry, 2015). OECD projected that the global water demand will increase by 55% in the next 30 years, while growing demand from thermal electricity generation is considered to be one of the main reasons for this growth (OECD, 2017). Furthermore, growing demand for digital services means that the data centers that power them are responsible for about 2% of global greenhouse gas emissions, which is a similar share to aviation (Vaughan, 2015). GeSI's SMARTer 2020 report indicates that data centers have the fastest rate of growth regarding carbon footprint and CO_2 emissions from 2011 to 2020 (Neves & Krajewski, 2012). According to the McKinsey Sustainability and Resource Productivity Report, carbon emissions from data centers around the world are expected to increase to 340 megatons annually by 2020 (McKinsey & Company, 2010). Since digitization is having an impact on both the personal and professional worlds, enthusiasm for big data, cloud computing, and digital services continues to grow, and data centers are asked to do more, which creates the need for more bandwidth, computing power, and live and offline storage. IBM estimated that each day 2.5 quintillion bytes of data centers are created word-wide (Morton, 2016). Moreover, analysts predict the number of people online until 2019 will increase by 60% due to the efforts of companies to expand Internet access by any means necessary. Therefore, the amount of data people will be using could grow to an outstanding 121 billion gigabytes (Walsh, Time Inc., 2014). Such global data consumption needs would further lead to increase in operational costs, profitability reduction and financial inefficiency (CIOReview, 2016). Ian Bitterlin, Britain's foremost data expert warned "*If we carry on going the way we have been it would become unsustainable – this level of data center growth is not sustainable for next 10 to 15 years"* (Bawden, 2016).

The latest findings suggest that the impact of data centers on corporate social responsibility strategies is being hidden by lack of clear energy efficiency definitions. According to the Green Grid's EMEA Research on Data Center Energy and Resource Efficiency, 43% of the companies do not define energy objectives, casting doubts over both how are they monitored and their corporate social responsibility strategy contribution (Lima, 2016).

Corporate Social Responsibility (CSR) is the derivative of sustainable development whereby companies integrate social and environmental concerns in their business operations and interactions with their stakeholders. It is generally understood as being the way through which company achieves a balance of economic, environmental and social imperatives ("Triple Bottom-Line Approach"), while at the same time addressing the expectations of shareholders and stakeholders (Miryala & Mennakanti, 2016). Making sustainability an integral part of company's business strategy in order to obtain the bottom-line benefits is challenging and requires changes in the organizations' performance against the economic, social and environmental (triple) bottom-lines, as well as sound management framework that integrates environmental and social performance with economic business performance (Sebhatu, 2009). Since traditional measurement and management systems are not designed for a balanced view of financial, environmental and social metrics, the challenge for Performance Measurement Systems (PMS) is to supplement operational and strategic levels with useful tools and sustainability can play the major role for change in PMS (Klovienė & Speziale, 2015).

This study provides an overview of conceptual frameworks for the integration of social and environmental responsibility concerns into PMS and elaborates their characteristics as well as procedures for their implementation. In addition, it provides a comprehensive analysis of different PMS models, and also gives an insight into possible solutions for better energy efficiency and data center's sustainability.

1.2. Research questions

This research is done to provide data center's managers, operators, and designers/ engineers deeper knowledge on adopting PMS to integrate the three dimensions of sustainability (economic, social, environmental) into data center's mainstream business activities. Specifically, the purpose of this paper is to investigate PMS models which could help data centers' to integrate sustainability within their corporate strategy in order to become "greener". Therefore, the theoretical framework of the paper focuses on the use of PMS to communicate and implement corporate strategies through proactive CSR thinking in order to merge both economic and non-economic issues as well as measuring non-economic perspectives of the organization. By summarizing introduction above main research question can be formed:

"How can PMS contribute to data centers' sustainability?"

In order to answer the main question, following sub-questions are formulated:

- What are the potential PMS models, techniques and methods to integrate sustainability within data centers' corporate strategy?

- What solutions do PMS provide to data centers' to help them improve their sustainability?

1.3. Methodology

According to the nature and purpose of this research, literate review is used as the main tool to provide more insightful understanding of the research problem. A literature review can be explained as critical analysis of a segment of a published body of knowledge through summary, classification, and comparison of prior research studies, reviews of literature, and scientific articles. By answering the main research question and sub questions the conclusion, policy and limitations of this research are formulated.

Main research question of this thesis will be answered by using data from researches done in the past 20 years on performance measurement systems (PMSs) and researches done within past 10 years in the field of sustainable development and performance. It includes the research and selection of reliable articles, taken from web-sites and scientific articles as well as information and data collected directly from the web sources related to data center sustainable development. In order to increase the objectivity of this research, reports of global campaigning organizations, consulting firms and associations will be also taken in consideration as a trustable source of information.

Article search engines

The following search engines will be used to identify relevant articles:

- Google Scholar
- Google Advanced
- Saxion Library
- Science Direct
- Elsevier
- Emerald Insight
- Springer Link
- Wiley Online Library

Type of research

By using aforementioned engines, the following media will provide relevant information and materials:

- Articles from journals
- Newspaper and magazine articles
- Books and e-books
- Reports
- Websites
- Other type of information

Identification of keywords: performance measurement systems (PMS), corporate social responsibility (CSR), the triple bottom line (TBL), sustainability, performance measurement, data center sustainable development, data center sustainable performance.

1.4. Structure and object

Structure of the thesis

Chapter I of the study gives an overall view of data center's performance and corporate social responsibility issues. In addition, the use of PMS aligned with the TBL principles is suggested pathway to integrating sustainability within data center's corporate strategy. Also, in this chapter main research aims and objectives of the research questions, as well as methodology including structure and object of this thesis are described.

Chapter II provides Theoretical Framework to introduce the reader of this research with terms which are necessary for further reading and understanding. It contains a brief description of PMS and review of different conceptual frameworks for the integration of sustainability into data center's corporate strategy. In addition to elaborating the basic features of PMS models, in this chapter, the systematic and critical analysis of each model is carried out and will be further used in the Conclusion to provide opinion whether the research aims were met.

Chapter III describes the context of data centers regarding implementation of PMS, and provides insight into PMS solutions for data center sustainability and resource optimization.

Chapter IV contains a Conclusion based on the key findings and analysis of this research. Also, in this chapter policy, limitations and author's reflection will be given.

Object

The main purpose of this thesis is to investigate PMS and in which way data centers could integrate sustainability within their corporate strategy by using different PMS models, techniques and methods. Specifically, the object of the study is to provide an answer on main research question: „How can PMS contribute to data center's sustainability?"

This study might be of great interest for those who are aiming to improve performance management in data centers' as well as those who attempt to integrate sustainability as a main part of data center's corporate strategy. The findings in this research should point data center's managers, operators, and designers/engineers to a more effective way of decision-making and management control within a data center.

Chapter II. Theoretical framework

2.1. The concept of Sustainability and Sustainable Development

According to Ciegis (et al, 2009), economic literature offers over hundred definitions on sustainable development, mostly oriented towards separate sectors – e.g. environmental, economic, civilization – or emphasizing managerial, technical or philosophical/ political decisions, and therefore expressing rather different concepts of sustainable development. Considering the fact that none of the hundreds definitions of sustainable development find in the literature include all the aspects of the concept and provide perfect understanding of it, the most appropriate definition that best expresses the idea of sustainable development is provided in the report of the Brundtland commission, stating that "sustainable development is the development that satisfies the needs of the current time period without threatening the ability of future generations to satisfy their needs" (Ciegis, Ramanauskiene, & Martinkus, 2009).

Furthermore, Spanberg (et al, 2000) suggest that sustainability issues should be analyzed and solved on the system levels where they develop and manifest themselves, and that one can consistently formulate respective aims of sustainable development policy for separate dimensions (economic, ecological, social, and institutional) of sustainable development on each of these levels of the economic development policy. Thus, the matrix of the aims of sustainability policy may be used when preparing sustainability scenarios. In addition, Bivainis and Tuncikiene (2007) argue that a number of modeling approaches, using different simulation tools, have shown that such scenarios can be constructed in a coherent and workable manner (Ciegis, Ramanauskiene, & Martinkus, 2009).

2.2. The concept of Corporate Social Responsibility (CSR) and Sustainability Reporting

The concept of Corporate Social Responsibility (CSR) as a concept whereby companies taking responsibility for their impact on society was first introduced by the European Commission (EC) (2001). According to the EC being socially responsible not only means fulfilling legal expectations, but also going beyond compliance and investing more into human capital, the environment, and the relations with stakeholders. The importance of CSR is that provides important benefits to companies in risk management, cost savings, access to capital, customer relationships, and HR management. In addition, CSR makes companies more sustainable and innovative, which contributes to sustainable economy (European Commission, 2017).

According to PwC, effective sustainability reporting is a powerful part of communicating with stakeholders about how company performs against its own objectives. Moreover, companies that embrace sustainability reporting are likely to have advantage over their competitors and boost value to shareholders (PwC, 2017).

Global Reporting Initiative (GRI), an independent international organization that has been pioneered sustainability reporting since 1997, consider a sustainability report is the key platform for communicating sustainability performance and impacts since it helps organizations to measure, understand and communicate their economic, environmental, social, and governance performance, set goals and manage change more effectively (Global Reporting Initiative, 2017).

According to GRI, sustainability reporting should benefit all reporting organizations, both internally and externally. Internal benefits for companies and organizations can include:

- increased understanding of risks and opportunities
- emphasizing the link between financial and non-financial performance
- influencing long term management strategy
- streamlining processes, reducing costs, improving efficiency
- benchmarking and assessing sustainability performance
- avoiding being implicated publicized environmental, social, and governance failures
- comparing performance internally, and between organizations and sectors

(Global Reporting Initiative, 2017).

In addition to internal benefits, external benefits of sustainability reporting can include:

- mitigating or reversing negative environmental, social and governance impacts
- improving reputation and brand loyalty
- enabling external stakeholders to understand the organizations true value, and tangible and intangible assets
- demonstrating how the organization influences, and is influenced by, expectations about sustainable development

(Global Reporting Initiative, 2017).

2.3. The Triple Bottom Line (TBL)

The Triple Bottom Line (TBL) term was coined in the 1990's by business consultant John Elkington to describe social, environmental, and social value of an investment. The TBL accounting framework goes beyond the traditional measures of profits, return on the investment, and shareholder value in order to value assets and leverage resources of a firm in a more accurate way, so that capital is employed as efficiently and effectively as possible. The concept is commonly referred to as the 3Ps (people, planet, profit), triple value adding, and blended value (Hammer & Pivo, 2016).

Moreover, people inside and outside academia who have studied and practiced sustainability would agree with the general definition of Andrew Savitz for TBL. According to Savitz, the TBL captures the essence of sustainability by measuring the impact of an organization's activities on the world including both its profitability and shareholder values and its social, human, and environmental capital (Slaper & Hall, 2011).

The application of the TBL by businesses, non-profits and governments are motivated by the principles of economic, environmental and social sustainability, but differ with regard to the way they measure sustainability on three fronts – people, planet, and profits. The flexibility of the TBL allows organizations to apply the concept in a manner suitable to their specific needs (Slaper & Hall, 2011).

2.4. Performance Measurement Systems (PMS)

Today's companies understand that for competing in continuously changing environment, it is necessary to monitor and understand firm performances – therefore measurement has been recognized as an essential part to improve firm performance (Roshan & Joseph, 2014). The literature defines the term "performance" as the ability of an entity, such as person, group or organization, to make results in relation to specific and determined objectives. In addition, performance is described as an actual work or output produced by a specific unit or entity. Otherwise, the performance concept refers to measurable achievements produced (Zeglat, AlRawabdeh, AlMadi, & Shrafat, 2012). In the context of sustainability, sustainable performance can be defined as the performance of a company in all dimensions and for all drivers of corporate sustainability (Schaltegger & Wagner, 2006).

According to BPIR, measurement refers to quantitative information that quantifies input, output, and performance dimensions of processes, products, services, and the overall organization (Business Performance Improvement Resource, 2017).

Numerous researchers in order to explain this complex concept have exposed the definitions of terms performance measures (PM) and performance measurement system (PMS) (Milanovic Glavan, 2011). Performance measurement has been defined as the process of quantifying action, where measurement is the process of quantification and action leads to performance. In accordance with, PM is defined as a metric used to quantify the efficiency and/or effectiveness of an action. Hence, a PMS can be defined as a set of metrics used to quantify both the efficiency and effectiveness of actions (Neely, Gregory, & Platts, Performance measurement system design: A literature review and research agenda, 1995).

According to Thomas (2006), PM serve numerous purposes. The aims of PM are:

- to help clarify organization goals, direction and expectation
- to help organizations learn how to accomplish goals more effectively
- to communicate the priorities of organization
- to support strategic/ business line planning by linking broad statements of direction to specific operational outputs and outcomes
- to support budgetary planning and resource allocation processes
- to monitor the operation of the programs and to make continue improvements
- to motivate public servants and to restore pride within the public service that it is making a positive contribution
- to enable citizens to make better informed decisions in the use of public programs
- to restore public confidence that they are receiving value for money in public spending
- to assess whether the organization is achieving its goals
- to strengthen internal administrative and external policy accountability

(Thomas, 2006).

Sinclair and Zairi (1995) emphasize the need for PM by providing a list of seven topics. Therefore, PM:

- enhances improvement
- ensures that managers adopt a long-term perspective
- makes communication more precise
- helps an organization to allocate its resources to the most attractive improvement activities
- is central to the operation an effective and efficient planning, control, or evaluation system
- affects the motivation of individuals and encourages right organizational behavior
- supports management initiatives and manages change

(Riratanaphong, 2014).

Parker (2000) mentioned several reasons why companies should use PM, in order to:

- identify success
- identify whether they are meeting customer requirements
- understand their processes (to inform what they know or reveal what they do not know)
- indentify where problems, bottlenecks and waste exist and where improvements are necessary
- ensure that decisions are based on facts, not supposition, emotion or intuition
- show if the improvements planned actually happened

(Riratanaphong, 2014).

Furthermore, Brown and Delvin (1997) define a PMS as a complete set of performance measures and indicators derived in a consistent manner according to a forward set of rules and guidelines. According to Nani (et al., 1990) it is a means to monitoring and maintaining organizational control, i.e. the processes of ensuring that an organization goes after strategies that lead to the achievement of overall goals and objectives (Riratanaphong, 2014). Similarly, Morgan (2004) considers the PMS a strategic tool with a wide variety of metrics used by management to monitor and guide company toward successful desirable objectives and goals (Zeglat, AlRawabdeh, AlMadi, & Shrafat, 2012). Simons (2000) describes PM as a tool which allows managers to balance the tensions between growth versus control, short-term performance versus long-term performance, and opportunities versus threats.

According to CIMA's "Performance Measurement" report (2006) PM in relation to management accounting is defined as the process of assessing the proficiency with which a report entity succeeds, by the economic acquisition of resources and their efficient and effective deployment, in achieving its objectives (Harvey, 2006).

Interoperability Glossary of Terms (2005) describes PM as the process of developing measurable indicators that can be systematically tracked to assess progress made in achieving predetermined goals and using such indicators to assess progress in achieving these goals (Harvey, 2006).

Within the context of sustainability, a PMS refers to a 'sustainability performance measurement system' (SPMS). A SPMS could be defined as an integrated system of indicators, measures and indices, as well as management of the interaction between business, society and the environment that provides information on progress towards defined goals to help manage economic, social and environmental impacts of a company, and focus on a long term view of business performance (Searcy, 2016).

The importance of PMS lies in the fact that it not only improves the performance, but also the productivity of a business entity by reducing costs. It is a good way to align the activities with the plans being established. Moreover, performance measurement process is a great way to understand, manage, and improve overall functioning state of a business organization. If performance measurement process is done effectively and efficiently, it definitely drives success in business (Siddiqui, 2015).

Benefits of effective PMS

There are many substantial benefits that can be realized by companies implementing PMS. The PMS as a process:

- supports continuous learning in which feedback is used for indentifying achievement and making adjustments to agreed-upon strategies or initiatives to ensure continued excellence of activities and services, and to progress for the attainment of organizations mission, vision and objectives
- provides a balanced and systematic attempt to assess the effectiveness of organizations operations from different point of view: financial, clients, internal processes and employees, as well as the essential feedback to improve decision making in organizations at all levels: strategic, operational and individual level

In addition, performance measurement is not simply concerned with collecting data associated with a predefined performance goal or standard. As an overall management system PMS:

- involves prevention and detection aimed at achieving conformance of the work product or service to the customer requirements
- is concerned with process optimization through increased effectiveness of the process or product

(The KPI Institute Pty. Ltd., 2017).

Reported benefits of effective performance measurement are also described in CIMA's "Performance Measurement" report (2006). Accordingly, benefits from an effective measurement system include and are not limited to the following:

- enhanced decision making and control
- supported strategic planning and target setting
- improved communication
- accountability (Harvey, 2006).

2.5. Review of Performance Measurement models, frameworks and techniques

The Balanced Scorecard (BSC)

As a response to traditional measures, because they do not assist in effective management, Robert Kaplan and David Norton (1992a) developed a framework called "Balanced Scorecard" (BSC). The BSC (1992a, 1993, 1996a, 1996b, 1996c, 2000, 2001a) indentifies the influence of non-financial factors upon strategic success and present advantages over traditional performance measures. Moreover, it contains a set of measures that offers top managers a fast but comprehensive view of the business. According to Martin (1997), while traditional performance indicators tend to measure financial and accounting aspects, impacting long-term productivity and profits, BSC provides the measures of synthetic indicators which companies should focus on, such as customer reactions, profits, quality and flexible production selection (Shodhganga, 2017).

Butler (et al. 1997) recognized early that the BSC is more than a performance measurement technique and considered to be a management system (Khozein, 2012). Talbot (1999) suggests that BSC serves companies to integrate strategy, organization framework and vision into management systems, translate the long-term strategy and innovation of customer value into operational activities, and, finally, balances the competitiveness and short-term fortunes of stockholders through blending of traditional and modern indicators (Shodhganga, 2017). Moreover, Hanson & Towle (2000) consider the BSC to be a management philosophy as well as performance management system (Khozein, 2012).

The Balanced Scorecard Institute (BSI) recognizes the BSC to be a strategic and planning management system that organizations use to:

- communicate what they are trying to accomplish
- align the day-to-day work that everyone is doing with strategy
- prioritize projects, products and services
- measure and monitor

(Balanced Scorecard Institute, a Strategy Management Group company, 2017).

The four perspectives of the BSC

According to Kaplan and Norton (2008), apart from financial measures successful companies assess their organizations based on the following perspectives, i.e. financial, customer, internal processes and learning and growth. In each of these four perspectives companies determine their goals, and objectives for evaluating success in each perspective, measures and targets, and indentify quantitative goals for all of these measures for the period considered (Poureisa, Ahmadgourabi, & Efteghar, 2013).

1. Financial perspective

Building a strategy usually starts with increasing of shareholder's value. Companies have two basic levers for their financial strategy: revenue growth and productivity. The revenue growth generally has two components: build the franchise with revenues from new markets, new products, and new customers; and increase value to existing customers by deepening relationships with them through expanded sales – for example, cross-selling products or offering bundled products instead of single products (Kaplan & Norton, 2000).

The productivity strategy also usually has two parts: improve the company's cost structure by reducing direct and indirect expanses, and use assets more efficiently by reducing the working and fixed capital needed to support a given level of business. In general, the productivity strategy yields results sooner than the growth strategy. But one of the principal contributions of building a strategy is to highlight the opportunities for enhancing financial performance through revenue growth, not just by cost reduction and improved asset utilization. Also, balancing the two strategies helps to ensure that cost and asset reductions do not compromise a company's growth opportunities with customers' (Kaplan & Norton, 2000).

2. Customer perspective

The core of any business strategy is the customer value proposition, which describes unique mix of product and service attributes, customer relations, and corporate image that a company offers. The customer perspective defines how the organization will differentiate itself from competitors to attract, retain and deepen relationships with targeted customers.

The value proposition is crucial because it helps organization connect its internal processes to improved outcomes to its customers (Kaplan & Norton, 2000).

3. Internal process perspective

Once an organization has a clear picture of its customer and financial perspectives, it can then determine the means by which it will achieve the differentiated value proposition for customers and productivity improvements to reach its financial objectives. The internal process perspective captures these critical organization activities, which fall into four high-level processes: build the franchise by innovating with new products and services and by penetrating new markets and customers segments; increase customer value by deepening relationship with existing customers; achieve operational excellence by improving supply chain management, the cost, quality, and cycle time of internal processes, asset utilization, and capacity management; and become a good corporate citizen by establishing effective relationships with external shareholders (Kaplan & Norton, 2000).

4. Learning and growth perspective

The foundation of any business strategy is the learning and growth perspective, which define core competencies and skills, the technologies, and the corporate culture needed to support an organization's strategy. These objectives enable a company to align its human resources and information technology with its strategy. Specifically, the organization must determine how it will satisfy the requirements from critical internal processes, the differentiated value proposition, and customer relationships (Kaplan & Norton, 2000).

Integrating sustainability into BSC

In accordance with Butler, Henderson & Raiborn (2011), once an organization establish its approach to sustainable operations, next step of the management is to decide in which way sustainable operations will be reported and assessed using the BSC. Options for integrating sustainability into the BSC include the following:

1. Adding an additional perspective of a BSC
2. Developing a separate sustainable balanced scorecard (SBSC)

3. Integrating the measures throughout the four perspectives

(Butler, Henderson, & Raiborn, 2011).

1. Adding an additional perspective of the BSC

Adding an additional perspective to the BSC may be the simplest and easiest approach for companies that want to emphasize sustainability as a key corporate value or a critical strategy. The sustainability perspective consists of social and environmental performance indicators that link with the other four BSC perspectives and highlight the significance of social, environmental and economic responsibility as a corporate goal. However, Figge (et al, 2002) implies that the use of a separate sustainability perspective is questionable since linking sustainability measures to a company's economic well being and strategies may be difficult or even impossible, partially because market-based prices for goods and services may not fully reflect environmental and social activities. According to Zingales, O'Rourke & Orsatto (2002), having a stand-alone category would allow management to set up less-definite measurements without compromising organizational aggregation (Butler, Henderson, & Raiborn, 2011).

In contrast, setting apart sustainability measures in an independent perspective might reduce the strength of environmental initiatives by not providing a clear connection to the other perspectives and to corporate strategies. Such a lack of certainty, in turn, could weaken management's commitment to sustainable business practices. Besides, this additional-perspective approach could result in better visibility but it does not necessarily increasing importance of the sustainability aspects of corporate management. Bieker & Gminder (2001) suggest that additional-perspective approach however would enhance the status of sustainability for the company, but is specifically found only in companies with high-profile exposure to sustainability issues (Butler, Henderson, & Raiborn, 2011).

2. A Sustainability Balanced Scorecard (SBSC)

The second option to including sustainability measures in the BSC is to design and implement a separate sustainability balanced scorecard (SBSC). A separate SBSC is suitable for many companies, such as those that have no existing BSC but want to measure or integrate sustainability without the disruption and cost involved in adopting a full-scale BSC. Moreover, SBSC may be equally applicable to companies that already have functional BSCs and do not want to change them (Butler, Henderson, & Raiborn, 2011).

A separate SBSC can also be used by companies that want to emphasize corporate sustainability as a key value or critical strategy without revising the original BSC format (Butler, Henderson, & Raiborn, 2011).

Dias-Sardinha, Reijnders & Antunes (2002) suggest that an SBSC include the following four perspectives: sustainability, stakeholders, processes and learning. According to Elkington (1998) the sustainability perspective emphasizes the triple bottom line (TBL) of economic prosperity, environmental quality, and social justice. Moreover, Dias-Sardinha, Reijnders & Antunes (2007) consider the stakeholder perspective would incorporate measures of business ethics, labor practices, and impact on society; the processes perspective would focus on specific organizational internal and external processes, product tools and systems; and the learning perspective would stress organizational synergy, training and research and development (Butler, Henderson, & Raiborn, 2011).

According to Bieker & Gminder (2001) the strength of the SBSC is that a well-defined corporate sustainability strategy is not crucial to its development. In fact, SBSC literally can be used to develop a sustainability strategy. However, a potential disadvantage of the SBSC approach is similar to that of having a separate sustainability perspective since the free-standing nature may fail to help the company tie sustainability directly into corporate strategy (Butler, Henderson, & Raiborn, 2011).

3. Integrating sustainability measures throughout the four perspectives

Bieker & Gminder (2001) point out sustainability measures should be blended in day-today operations, and integrating sustainability measures into the major BSC perspectives can be one way to achieve this goal. Integration signifies that management recognizes there are cause-and-effect relationships between corporate strategies and sustainability efforts. As such, management is required to both define the metrics that are important in measuring progress toward organizational sustainability objectives and understand how the sustainability progress will influence success or failure of organizations (Butler, Henderson, & Raiborn, 2011).

Integrating the new measures into the existing perspectives has the additional advantage of allowing the measures to be seen as crucial to day-to-day operations and as central to the company's financial well being as customer satisfaction, manufacturing cycle efficiency, and patent-generating research and development. Accordingly, the integrated approach works well for companies that have a BSC in place and are willing to develop that scorecard to reflect sustainability practices (Butler, Henderson, & Raiborn, 2011).

Sustainability metrics can be added to or substituted for some existing measures and no major changes to the BSC design or reporting are likely to be required. Integration is also useful for organizations that are in the BSC development stage and believe it is essential to highlight sustainable development practices. Such organizations will readily be able to cohesively integrate sustainability and more traditional measures (Butler, Henderson, & Raiborn, 2011).

The integrated approach also works sufficiently for organizations that have adopted a more all-encompassing definition of sustainable practices that contains environmental, health, and social aspects. Such organizations may find that, because of the depth of focus, the process of integrating into the four major BSC perspectives is relatively smooth. Environmental measures are often responsive to the internal business processes perspective, health measures to the learning and growth perspective, and social measures to customer perspective. Since the measures become part of part of day-to day operations that are, in turn, connected to the firm's financial success, organizations may be less likely to drop sustainable measures in times of financial downturns (Butler, Henderson, & Raiborn, 2011).

Furthermore, integration of sustainability measurements can range from a partial approach, in which only a few sustainability performance indicators are added into some of the perspectives (often internal business processes or customers), to a comprehensive approach, in which sustainability issues are integrated throughout all BSC perspectives. Therefore, organizations should seriously consider the level of integration before adopting the measures (Butler, Henderson, & Raiborn, 2011).

Implementation of the BSC

Although there are numerous BSC toolkits and building methodologies, the 9-step framework created by Howard Rohm of the Balanced Scorecard Institute was found to be most relevant, practical and implementable one (Watkins, 2013).

1. Step One: Organizational Assessment

First step of the scorecard building process is to finalize the BSC Plan which will detail, among others, all the teams that will be involved in the designing of the scorecard and the training they will require (Watkins, 2013).

Moreover, it involves conducting organization assessment of the following strategic elements: the mission and vision, SWOT, and organization values. Also, preparing a change management plan for the organization, which will define communications strategy in order to indentify the target audience, key messages, media channels timing, and messengers of the communication is a crucial part of the BSC implementation process (Watkins, 2013).

2. Step Two: Strategy

Second step is about determining the strategic themes, including strategic results, strategic themes, and perspectives, which are developed to focus attention on customer needs and their value proposition. The most important element of this step is to insure that the company has unpacked what its customers are looking for in terms of function, relationship and image to determine whether it provides value to its customers (Watkins, 2013).

3. Step Three: Objectives

Step three is about determining the organization's objectives – organization's continuous improvement activities, which should link to organization's strategic themes, perspectives and strategic results (Watkins, 2013).

4. Step Four: Strategy Maps

The objectives designed in third step are linked in cause-and-effect relationships to produce a strategy map for each strategic theme. Afterwards, the theme strategy maps are merged into an overall corporate strategy map that shows how the organization creates value for its customers and stakeholders (Watkins, 2013).

5. Step Five: Performance Measures

In step five, the performance measures are developed for strategic objectives. In addition, performance measures should be clearly defined and company is expected to design its performance targets (Watkins, 2013).

6. Step Six: Strategic Initiatives

Step six is where the projects that have to be undertaken to ensure the success of organization (the extent to which the organization fulfills its vision) are drafted and assigned. In order to build accountability throughout the organization, both performance measures and strategic initiatives are assigned to owners and documented in data definition tables (Watkins, 2013).

7. Step Seven: Software and Automation

This step involves automating the BSC system, and consists of analyzing software options and user requirements to make the most cost-effective choice. It is important to point out that purchasing software too early might limit creative strategic thinking, while purchasing software late could make difficulties while sustaining momentum of the new system, as performance reporting utilization is an early benefit to be apprehended from the process of building the BSC system (Watkins, 2013).

8. Step Eight: Cascading

Step eight appears to be the key step regarding organization alignment around strategy. It involves cascading the corporate scorecard throughout organization to business and support units. Optionally, objectives for customer-facing processes can be integrated into the alignment process to produce linked outcomes and responsibilities throughout the organization. As the scorecard management system is cascaded down through the organization, objectives became more operational and tactical, as well as the performance measures (Watkins, 2013).

9. Step Nine: Evaluation

Final step involves evaluating the success of chosen business strategies. The key question asked is: Were the expected results achieved?

The evaluation step includes the following:

- ensuring that organizational learning and knowledge building are incorporated into planning
- making adjustments to existing service programmes
- adding new programmes in case they are more cost effective
- eliminating programmes that are not delivering cost effective services or meeting customer needs
- linking planning to budgeting

BSC in practice

BSCs are used largely in business and industry, government and non-profit organizations worldwide. According to Gartner Group, over 50% of large US companies have adopted the BSC. Besides, more than a half of major companies in the US, Europe, and Asia are using the BSC, with use growing in those areas as well as in Middle East and Africa. A recent global study performed by Bain & Co (2004) listed BSC fifth on its top ten most widely used management tools around the world, a list that includes closely-related strategic planning at number one (The Balanced Scorecard Institute, 2017).

Advantages and disadvantages of the BSC

The first advantage of using the BSC method is that by looking at four aspects of a company's performance, user really does get a balanced view of company performance. Moreover, the BSC gives user a full picture a complete picture as to whether the company is meeting its objectives. While it may seem that a company is doing well financially, it may be that a customer satisfaction is down, employee training is inadequate, or that the processes are outdated. Second, using BSC allows for stakeholders to determine the health of short, medium, and long-term objectives at a glance (Bowen, 2011).

Finally, by using a BSC, a company can be sure that any strategic action implemented meets desired outcomes. For instance, raising the price of a product might help the bottom-line of the company in the long run if customer is satisfied with that product, or if the processes involved guarantee higher quality of a product (Bowen, 2011).

Although the BSC can be an effective way to organize and manage an organization's business activities, many companies have found that it comes with a certain drawbacks such as cost and time, incomplete information, or employee resistance. For maximum effectiveness, the entire organization should understand the theory behind the BSC to have knowledge of how it works. That is no small feat and can be challenging, especially for small companies to accomplish. Also, the usefulness of the BSC depends on the value of information that is driving the process. That means the tool will only work if the right elements have been selected for the review and if the information used to evaluate the process is complete, accurate and relevant to the area being addressed. Lastly, some employees and even managers refuse to implement the BSC because the implementation process requires employees to go through training activities or invest additional time to learn about the BSC and its use (Richards, 2017).

The Performance Prism

The Performance Prism is a performance management framework introduced by Andy Neely and Chris Adams (2000). It is a model designed to assist performance measurement selection and to address the key business issues to which organizations, profit or non-profit, will be able to relate (Adams & Neely, 2001). To reflect the growing importance of satisfying stakeholder requirements, the Performance Prism adopts a stakeholder centric view of performance measurement. Although for many organizations shareholders are the most important stakeholder, the Prism also considers important stakeholder groups such as other investors, customers, employees, and suppliers (Neely, Business Performance Measurement: Theory and practice, 2004). Moreover, it provides support to managers in the management of the enterprise and which they can adapt to their needs. Unlike the other frameworks, the Performance Prism requires analysis of stakeholders and their needs before considering strategy and it also considers what processes and capabilities are required to support the strategy before indentifying appropriate performance measures. This should lead to performance at all levels of the organization, and help it to meet the interests of the stakeholders (Adams & Neely, 2001).

The Performance Prism aims to manage the performance of an organization from five interrelated perspectives:

1. Stakeholder satisfaction – 'Who are our stakeholders and what do they want and need?"
2. Strategies – "What are the strategies we require to satisfy the wants and needs of our stakeholders?"
3. Processes – "What processes we have to put in place in order to execute our strategies?"
4. Capabilities – "What are the capabilities we require to operate our processes?"
5. Stakeholder contribution – "What do we want and need from our stakeholders?"

(Adams & Neely, 2001).

Integrating sustainability into the Performance Prism

Dylick and Hockerts (2002) pointed out that the Performance Prism is an effective tool because stakeholder's satisfaction is important to achieve corporate sustainability (Ceglia, 2017). Moreover, Maletic, Maletic & Gomiscek (2014) presented a conceptual framework to integrate social, environmental and economic issues into organizational practice. Their framework is consistent with the Performance Prism created by Nelly and Adams (2000) and is used as a guide for addressing stakeholder's wants and needs in the view of sustainability. According to their work, *stakeholder identification* has proven to be a necessary approach of any sustainability performance model since it emphasizes that the green new product and service development process appears to extensively involve external shareholders. As far as *strategies* are concerned, it is important that strategic planning is in the first place linked to stakeholders as well as to organization's vision (Maletic, Maletic, & Gomiscek, 2014).

Green development and environmental aspects appears to fit with the *processes dimension* and should include conceptual tools such as pollution prevention, product stewardship and CSR. Banerjee (2001) highlighted the environmental initiatives lead to benefits for organization which aims to reduce waste, save costs and make improvements in product and process quality. In addition, the efforts to improve business operations that are aligned with sustainability are also described in the work of Rao and Holt (2006), who indicate that greening the inbound function, as well as greening production, significantly lead to the greening outbound, as well as to competitiveness and economic performance of the company (Maletic, Maletic, & Gomiscek, 2014).

According to the U.K. Department of Business, Innovation and Skills (2012), only during 2010-2011, global sales of low carbon and environmental goods and services were measured at roughly 5.2 trillion dollars with 48 percent of total coming from low-carbon activities, 31 percent from renewable energy and 21 percent from environmental activities what resulted in annual of 3.7 percent from the previous year (Cohen, 2013).

Employee support is the next category that is aligned with the *capabilities dimension*. It captures the common underlying dimension of sub-theme related to capabilities that foster the competence by business to operate in more sustainable and innovative way. From the resource-based point of view, Widen, Gudergan and Lings (2011) consider resources (i.e. inputs for the production of goods and provision of services) and organizational capabilities (i.e. intangible assets that are based on skills, learning, knowledge in deploying resources) sources of competitive advantage (Maletic, Maletic, & Gomiscek, 2014).

Implementation of the Performance Prism

Neely and Adams (2003) identified four fundamental processes that underpin development and arrangement of a PMS:

1. the Design process
2. the Plan and Build process
3. the Implement and Operate process
4. the Refresh process

Moreover, the following narrative outlines the experience of DHL UK, which applied the Performance Prism framework in late 1999 (Neely & Adams, www.littoralis.info, 2003).

1. The Design process

During the design phase, the executive team of DHL participated in a series of workshops where they explored their shared understanding of the organization's strategy and plan for the future. The first round of workshops was structured so that the DHL executive team identified the wants and needs of their stakeholders as well as their contribution to the business (Neely & Adams, www.littoralis.info, 2003).

Further, the outputs from the first round of workshops were taken as the inputs to the second, where the executives were asked to identify the strategies, processes and capabilities the organization would need to have in place to satisfy wants and needs of its shareholders. DHL had to begin with recognizing that the organization had several different kinds of customers. Therefore, they categorized their customers into three separate and distinct segments – Advantage, Regular and Ad Hoc – based on customer needs. In addition, specific strategies, processes and capabilities relevant to each customer segment were then identified (Neely & Adams, www.littoralis.info, 2003).

The third set of workshops was focused on getting the executive team to think about what questions they would like to be able to answer at their quarterly performance reviews, regarding the structure of the success map they had developed. Once the right questions have been identified, it becomes relatively forthright to think what should be measured (Neely & Adams, www.littoralis.info, 2003).

Finally, the fourth and the last set of workshops for DHL UK was focused on measures required and data needed, to answer the questions indentified by the executive team. These workshops involved the business's performance analysts and members of the executive team. Moreover, the role of business's performance analysts was to provide insights into business performance for the executive team, what in the end resulted in a set of measures that have been mapped onto specific questions that the executive team had identified (Neely & Adams, www.littoralis.info, 2003).

2. The Plan and Build process

Once the performance measures have been selected and defined, DHL started with the plan and building phase of the process. Fortunately, the organization already had in place much of data capture infrastructure, so there was only a limited need to develop reporting capabilities. DHL did, however, invest a significant amount in education and process facilitation which means that this investment was fundamental to the successful implementation of the model (Neely & Adams, www.littoralis.info, 2003).

3. The Implement and Operate process

The starting point of this phase was to restructure of the agenda for the business's quarterly performance reviewers, so that the discussions that would take place would reflect the key questions that the executive team had decided they should addressing. DHL introduced the new structure during the June 2000 quarterly performance review and evolved over the next 12 months (Neely & Adams, www.littoralis.info, 2003).

A year after the launch of the process, and following regular appraisals prompted by the performance manager, the executive teams were still convinced that they were now concentrating on the right questions during their quarterly performance reviews. However, on this matter, DHL keep some insights confidential (Neely & Adams, www.littoralis.info, 2003).

4. The Refresh process

The process for DHL UK did not end with the implementation of the Performance Prism and the new quarterly performance review meeting structure. Instead, DHL continued to evolve their measurement system and review processes throughout the last years, and will continue to do so in the future (Neely & Adams, www.littoralis.info, 2003).

The Performance Prism in practice

The Performance Prism has so far been applied in a number of real-life situations, including the organizations such as DHL International, The London Youth, The House of Fraser, etc. It has also been used as the guiding framework seeking to suggest ways to improve success rate of mergers and acquisitions through improved measurement system. Moreover, Neely, Adams and Crowe (2001) have successfully applied the framework as the basis of the survey on the uses of measures in e-businesses. It has proved itself to be malleable to the various needs of a wide variety of different organizations and measures development conditions. In general, all organizations whishing either to implement a new set of measures or to upgrade their existing scorecard should consider applying the Performance Prism to the measures selection process (Adams & Neely, 2001).

Advantages and disadvantages of the Performance Prism

The Performance Prism main advantage over other frameworks is that it addresses all of an organization's stakeholders – mainly investors, customers and intermediaries, employees, suppliers, regulators and communities (Value Based Management.net, 2016). However, it offers little about how the performance measures are going to be implemented. Also, some of the measures are not effective in practice. Since there is no sufficient link between the results and drivers, no consideration is given the existing PMSs that companies may have in place (Spickova & Striteska, 2012).

The EFQM Excellence Model

The EFQM Excellence Model is a tool created by European Foundation for Quality Management (1991), which provides a holistic view of the organization and can be used in conjunction with any other management tools or techniques. Specifically, it is defined as an overarching framework for developing sustainable excellence (European Foundation for Quality Management, 2017).

The model was first used in 1992 with the effort to improve the position of European companies in competitive fight on global markets. It is designed to be a practical and pragmatic tool that enables organizations to assess where they are on path to excellence; helping them to understand their key strengths as well as their weaknesses in relation to their stated mission and vision (Jankal & Jankalova, 2016). According to Schreurs and Moreau (2006), the EFQM Excellence Model highlights the elements that affect performance enhancement and indicate the results that need to be measured. Moreover, it is based on the premise that the customer satisfaction, employee satisfaction, and the organizational impact on the community are achieved through strategy-based leadership and research management processes (Schreurs & Moreau, 2006).

The EFQM Excellence Model is based on 9 criteria. Five of these are 'enablers' and four are 'results'. The 'enabler' criteria cover what an organization does. The 'results' criteria cover what an organization achieves. 'Results' are caused by 'enablers' and 'enablers' are improved using feedback from results. In addition, innovation and learning helping to improve 'enablers' that in turn lead to improved 'results' (Schreurs & Moreau, 2006).

Each of the nine criteria has a definition which explains the high level meaning of that criteria:

1. Leadership

Leadership as equal important as products and processes are. Therefore, management can motivate the continuous improvement.

- How is management engaged in creating a culture of continuous improvement?
- How is management supporting the improvement activities?
- How is management evaluating and motivating the staff?

2. Policy and strategy

The EFQM is not only concerned with product and service quality, but with organizational policy and strategy as well. Policy deployment to ensure strategy is formulated and is known to management is important.

- The use of relevant information supporting the formulation of the strategy
- The formulation of strategy
- The implementation of strategy
- The communication about the strategy
- The evaluation and the improvement of the strategy

3. People

EFQM covers aspects of training and service quality and it also goes further requiring effective human resource development, teamwork empowerment, rewards and career planning.

- The organization of personnel management
- Deployment of expertise
- Participation of staff in organization

(Schreurs & Moreau, 2006).

4. Partnership and resources

Suppliers are becoming partners with emphasis on mutual beneficial relationships. Development and use of knowledge is point for attention. On point of resources, facilities need to be maintained for capability.

- The financial resources to realize continuous improvement
- How effective is the delivery of information?
- Relation with suppliers and procurement function
- The role of technology and knowledge management

5. Processes

The focus of EFQM is on the key processes necessary to deliver organizational strategy. Quality processes are important too.

- Identification of the processes
- Control and management of processes
- Evaluation and improvement
- Initiatives to innovation and to renovate the processes
- Implementation of process re-engineering

6. Customer appreciation

The major box requires evaluation of customer satisfaction through survey and interviews.

- Customer satisfaction
- Loyalty
- Customer focus

7. Functioning people in the organization

People within organization supposed to be surveyed with ideas such as team briefings and suggestion schemes to know their appreciation of the organization (Schreurs & Moreau, 2006).

- Satisfaction survey
- Functioning in the organization
- Personnel administration

8. Position in the society

EFQM asks companies to establish their impact on wider society, for example involvement in community activities.

- Role and link with society

9. Company results

EFQM requires measuring the results of the company in a BSC way.

- Financial measures
- Operational measures

(Schreurs & Moreau, 2006).

Integrating sustainability into the EFQM Excellence Model

Kumar and Balakrishnan (2011) have identified how the EFQM Excellence Model explains the concept of putting CSR into practice to support social responsibility and sustainability in following way:

- Sustainable organizations adopt a highly ethical approach by being transparent and accountable to their stakeholders for their performance as a responsible organization
- They give consideration to, and actively promote social responsibility and ecological sustainability both now and for the future
- The organization's CSR is expressed in its values and integrated within the organization

Through open and inclusive stakeholder engagement, they meet and exceed the expectations and regulations of the local and where appropriate, the global community

- As a well-managed risk, they seek out and promote opportunities to work on mutually beneficial projects with society inspiring and maintaining high levels of confidence with stakeholders
- They are aware of the organization's impact on both the current and future community and take care to minimize and adverse impact

Margaria (2004) stated that the EFQM framework for CSR is a new and integrated approach that uses the Excellent Model as a common base since it enables organizations to have an integrated approach to CSR. Furthermore (Neergard and Pedersen, 2003; Porter and Tanner, 2004) argue that the model is based on a stakeholder view of the company and companies can be excellent if they satisfy their stakeholder's needs. Bucur (2008) share the similar opinion considering the EFQM model a very effective management tool that combines CSR with stakeholder engagement in every activity of the organization and with many of the performance indicators (Jankal & Jankalova, 2016).

Implementation of the EFQM Excellence Model

Bauer (2002) suggested that implementation of the EFQM Excellence Model is effective if it is integrated into the organization and its processes in various ways:

1. Multi-level use of the EFQM Excellence Model
2. The use of the EFQM Excellence Model in strategic planning
3. The use of the EFQM Excellence Model in performance management
4. Alignment with other organizational systems
5. Staff involvement and teamwork

(Davies, 2008).

In the literature, a number of elements were found to be important for effective implementation of the EFQM Excellence Model:

- a clear motive for its use, particularly setting out clear expected benefits and objectives
- gaining senior management commitment
- demonstrating senior management commitment
- education and training
- activities to maintain momentum in the implementation process

(Davies, 2008).

The EFQM Excellence Model in practice

The impact of the EFQM Excellence Model since launched in 1992, was immense. It became immediately the standard Model for many of the National Quality Award schemes in Europe, Middle East, Asia, South America and South Africa. Moreover, many leading (global) organizations have adopted the EFQM Excellence Model as their business model, and in this way they have spread the Model throughout all their subsidiaries around the world. Although it is difficult to estimate precisely how many organizations are using the EFQM Model, it must be roughly around 50.000 organizational entities worldwide (Tossaint, 2016).

Advantages and disadvantages of the EFQM Excellence Model

The EFQM Excellence Model has many strong points. It is a systematic and non-prescription model that is strengthening the sense of quality. Furthermore, it recognizes strong and weak points of the organization, and creates conditions for comparative analysis of business processes with external business. In addition, the EFQM Model allows shortlist of indicators based on "good example" in practice (Spickova & Striteska, 2012).

On the other hand, the main weaknesses of the EFQM Model is that it is not a strategic management tool because of its systematic setting - therefore it is not used as an instrument for strategy implementation. Also, the Model is not suitable for enterprise communication and does not give guidelines how to design and conduct effective performance measurement (Spickova & Striteska, 2012).

Activity-Based Costing (ABC)

Activity-Based Costing (ABC) is a method developed by Cooper and Norton (1988), which is used for assigning costs to product and services based on the resources they consume (Drury, 2013). It is created as an alternative to traditional accounting in which a business's overheads (indirect costs) are allocated in proportion to the activity's direct costs more accurately, and in a much easier way (The Economist, 2009). Since these costs appear to have a significant effect on the way an organization does business, building a clear understanding of environmental impact and the actual costs associated with reducing the impact can provide an organization with a competitive advantage (Pember & Lemon, 2012).

Integrating sustainability into the ABC

According to CAM-I (2012), ABC is a proven method in the management of cost which helps companies to effectively manage their greenhouse gas (GHG) emissions (Pember & Lemon, 2012). The International Federation of Accountant (IFAC) in their international guidance document "Environmental Management Accounting" stated that setting up separate cost categories or cost centers for more obvious and discrete environmental activities is a common solution in resolving the issue of 'hidden' environment-related costs. Furthermore, they suggest that an assessment of the relative importance of environment-related costs and cost drivers of different processes and product lines, aligned with the general practice of ABC, can help an organization to determine whether or not the cost allocation bases being used are appropriate for those costs (The International Federation of Accountants, 2005).

The "Environmental Management Accounting Procedures and Principles" paper from the United Nations Division for Sustainable Development suggests that, whenever possible, environment-driven costs should be allocated directly to the activity that causes the costs and to the retrospective cost centers and cost drivers. Simply put, this would result in moving the GHG costs from the catch-all line item of overhead and directly assign them to particular activities and cost objects which can then be analyzed for performance (United Nations Division for Sustainable Development, 2001).

Extending ABC model to account for non-cost measures is a relatively simple process. The combination of cost and environmental measures within an ABC model provides a common language for the basis of cost/ profit and environmental measure management. In addition, applying ABC model to include GHG emissions can give organizations the ability to better manage the environmental sustainability costs of doing business (Pember & Lemon, 2012).

Implementation of the ABC

According to CIMA's "Activity Based Costing Topic Getaway" Report (2008), there are four steps to implementing ABC:

1. Identify activities

The organizations need to undertake an in-depth analysis of the operating processes of each responsibility center. Each process might consist of one or more activities required producing an output (Edwards, 2008).

2. Assign resource costs to activities

This involves tracing costs (direct, indirect, and general/ administration) to determine why the cost occurred (Edwards, 2008).

3. Identify outputs

Identify all of the output for which an activity segment performs activities and consumes resources. Outputs might be products, services or customers (Edwards, 2008).

4. Assign activity cost to outputs

This step is done using activity drivers. Activity drivers assign activity costs to outputs (cost objects) based on the consumption or demand for activities (Edwards, 2008).

The ABC in practice

ABC activities have been around for nearly 20 years and they are implemented by thousands organizations in variety of sectors (financial services, healthcare, insurance, etc.), and will continue to prove useful (Hartman & Ruhl, 2008). Initially, ABC was focused primarily on manufacturing industry where technological developments and productivity improvements had reduced the proportion of direct labor and material costs, but increased the proportion of indirect or overhead costs (Edwards, 2008).

However, it is estimated that no more than 10% of companies now using activity-based management in a number of their operations. The other 90% have given up, or their programs are stagnating or floundering (Cucuzza & Ness, 1995).

Nevertheless, ABC has many satisfied customers. Chrysler, an American car manufacturer, claims that it saved hundreds of millions of dollars through a programme that is introduced in the early 1990's (The Economist, 2009).

Advantages and disadvantages of the ABC

The SAS Insights study (2005) determined the state of ABC within over 500 organizations across many industries of different sizes and locations. One of the reported benefits regarding the use of ABC according to the findings in the study is that ABC provides a more accurate method of costing of products and services. Moreover, it allows for a better and more comprehensive understanding of overheads and what causes them to occur. Last but not least, ABC makes costly and non-value adding activities more visible, so allowing the managers to focus on mentioned areas to reduce or eliminate them. The method also supports other management techniques such as continuous improvement, scorecards and performance management (Edwards, 2008).

However, as far as drawbacks are concerned, the study suggests that ABC can be difficult and time consuming to collect the data about activities and cost drivers. It can be also costly to implement, run and manage an ABC system. Finally, it turns out that some overhead costs are difficult to assign to products and customers (Edwards, 2008).

2.6. Comprehensive overview of Performance Measurement models, frameworks and techniques (discussion/ comparison)

This section of the chapter provides a comprehensive overview of PMS based on the information gathered so far in this work. Table 1 shows potential PMS and their characteristics in order to make the comparison of the existing models more easily. The characteristics that are used to evaluate each PMS are:

1. Usability

Usability implies the ability of the model to perceive opportunities, threats and shortcomings.

2. Adaptability

Adaptability implies the ability of the model to adapt to different needs.

3. Connection with the corporate strategy

Connection with the corporate strategy implies the ability of the model to clearly link to and communicate a company's strategy.

4. Measurability

Measurability implies the ability of the model to measure the right things.

5. Implementation time and costs

Implementation time and costs implies time needed and costs for successful implementation of the model.

6. Sustainability integration

Sustainability integration implies the ability of the model to incorporate sustainability within company's corporate strategy and/ or business activities.

Characteristics	Performance measurement systems			
	The Balanced Scorecard (BSC)	The Performance Prism	The EFQM Excellence Model	Activity-Based Costing (ABC)
Usability	👍	👍	👍	👍
Adaptability	👍	👍	👍	👍
Connection with the corporate strategy	👍	👍	👎	👍
Measurability	👍	👎	👎	👍
Implementation time and costs	👎	👍	👎	👎
Sustainability integration	👍	👍	👍	👍

Table 1: PMS characteristics

Based on the table above, three things are common to all of the above mentioned models, and these are:

- their frequent use in practice,
- adaptability to different needs of the company, and
- the ability to incorporate sustainability within company's corporate strategy or business activities.

However, not all models are strategic management tools. This primarily refers to the EFQM Excellence Model, which has systematic setting that cannot be used for strategy implementation. As such, the EFQM Model is not suitable to communicate measures and does not provide guidelines for effective performance measurement.

Similarly, the Performance Prism does not belong to the group of models such as BSC and ABC, which are able to provide the right measures, since it offers little about how the performance measures are going to be implemented while some of the measures are not even effective in practice. Although the Performance Prism does not require much time for its implementation and is less expensive to implement than BSC, EFQM and ABC, it is rather model designed to assist performance measurement – unlike BSC and ABC, which are much more complex systems.

Considering that BSC, ABC, and EFQM require an additional time to invest and training activities to go through to learn about their use, some employees and even managers are not prone to their implementation. Regardless of this disadvantage, BSC and ABC model are able to provide companies with:

- multiple levels of analysis
- balance between internal state and activities inside of the company and activities and items external to the company such as customer, suppliers, competitors, market conditions, environmental conditions, etc.
- data quality and overall measurement trust (reliability, consistency, accuracy)
- higher level of performance

Taking into account all the information about PMS so far, BSC and/ or ABC should be the models considered for implementation in a data center. Except that these models are adaptable to the different needs of the enterprise and offer the possibility of integrating sustainability into company's corporate strategy, they also offer the right set of measures, and are proven to be effective in indentifying causes and effects to help managers better understand where to apply attention. In addition, both models are compatible and also support other management techniques. Although models like the Performance Prism and EFQM Excellence Model do not cover all business dimensions, they still can be used in combination with either BSC or ABC to assist performance measurement selection within a data center and enhance performance.

Chapter III. PMS in Data Center

3.1. Data center context

According to Weinman (2012), one might calculate the jobs impact of data center considering a company that uses its data centers to offer search, mail, video, apps, compute, storage, or other services over the Internet. Therefore, a large data center might have from 100 to as many as 300 on-site employees, and a large company might have a dozen such data centers, or even more, which means a couple of thousands employees (Weinman, 2012).

The European Commission in a statistical context defines entities with 250 or more people employed as a "large enterprise". However, the term "people employed" should not be confused with terms such as employees or full-time equivalents; "people employed" includes employees but also working proprietors, and partners working regularly in the enterprise (European Commission, 2016).

Roach (2007) states that large corporations are an economic, political, environmental, and cultural force that is unavoidable in today's globalized world since they have an impact on the lives of billion of people every day (Roach, 2007). Moreover, many activities that organizations employ on a daily basis would be unthinkable without the data centers' support. In the narrative, some of the advancements made possible by data centers being a hub of all business activities are certainly E-commerce and the Internet of Things (IoT) (Nilesh, 2015).

According to the "State of e-commerce: global outlook 2016-21" Report (2017), e-commerce sales worldwide will continue to grow in 2017, rising 23% to reach US$2.3tn. In addition, eMarketer's estimates that e-commerce sales will account for one-tenth of total retail sales worldwide in 2017 (International Post Corporation, 2017). Since online marketplaces are powered by data centers, and with the increasing number of customers who shop online, data center support is imperative to ensuring that these marketplaces and services are continually open for business. Thus, data centers are important part of today's growing online economy (Nilesh, 2015).

Furthermore, IoT as a concept is rapidly growing, and data center support is playing a major role in this (Nilesh, 2015). The IoT is the concept of basically connecting any device with an on and off switch to the Internet (and/ or to each other). This includes everything from cell phones, coffee makers, washing machines, headphones, lamps, wearable devices, machines, etc. (Morgan, 2014).

To get a broader view of the IoT's potential benefits and challenges across the global economy, McKinsey Global Institute issued a Report (2015) which estimates that IoT has a potential economic impact of $3.9 trillion to $11.1 trillion a year by 2025. At the top end, that level of value – including the customer surplus – would be equivalent to about 11% of the world economy (McKinsey Global Institute, 2015). Thus, data centers are a vital component of the IoT since they enable the essential data to be stored and transmitted for user applications, to the IoT devices themselves (Nilesh, 2015).

Findings in the literature suggest that larger companies are likely to engage multi-dimensional and integrated PMS combining both financial and non-financial information. Also, they tend to use more management tools (e.g. BSC, CRM, TQM) than their counterparts (Madsen, 2015).

3.2. What solutions do PMS provide to data centers' to help them improve their sustainability?

According to Borial (2013), sustainability reporting has become increasingly common practice in companies' attempts to respond to expectations and criticisms from the stakeholders who want to be better informed about the social and environmental impacts of business activities (Speziale & Kloviene, 2015).

PMS provides the possibility for data centers to measure their IT performance and improve problem areas. The metrics can range from granular technical information, used by data center staff, to key performance indicators (KPIs) that inform business groups relying on a data center. Moreover, the right metrics, aligned with business needs strengthen data center monitoring and capacity planning. This means PMS orient data center's performance to specific goals and helps data center's facility managers to measure the impact or success of IT. In addition, PMS measures the state of the IT infrastructure, including transactions, efficiency and agility (TechTarget, 2017).

According to Green Grid's „Carbone Usage Effectiveness (CUE): A Green Grid Data Sustainability Metric" report (2010), PMS can help IT organizations better understand and improve the sustainability and energy efficiency of their existing data centers, as well as help them make smarter decisions on new data center deployments. Moreover, the Green Grid Association believes that it is highly important for data centers' to promote efficiencies in other dimensions to maximize operational efficiency and reduce negative impacts on resources and the environment (Azevedo, Patterson, Pouchet, & Tipley, 2010).

With data centers being more sustainable, IT organizations can better manage increased computing, network and storage demands; decrease energy costs; and reduce total cost ownership while remain competitive and able to meet future business needs. Additionally, organizations that focus proactively on these issues will lower their business risks, increase their potential for growth, and better manage the environmental costs (Azevedo, Patterson, Pouchet, & Tipley, 2010).

Wang & Khan (2013) implied PMS brings solid specifications and definitions of sustainable data centers in following aspects:

- indentify and specify clearly how „green“ a data center is, for example by calculating data center's energy efficiency or greenhouse gas emissions per time unit
- evaluate data center products and compare similar data centers
- track „green“ performance to increase a data center's „green efficiency“
- provide guidance to engineers, manufacturers, and service providers to develop research and development of future green data center technologies

(Khan & Wang, 2013).

Sustainability metrics: PUE, CUE and WUE

The Green Grid Association recognized significance of implementing the metrics for data center sustainability. Accordingly, these metrics and their related processes can help the data center community better manage energy, environmental, societal, and sustainability parameters associated with building, commissioning, de-commissioning, and operating data centers. Ideally, the metrics and processes established to address data center sustainability will help organizations to decide whether an existing data center can be optimized before a new data center is needed (The Green Grid, 2010).

Power usage effectiveness (PUE)

PUE is one of the basic and most effective metrics for measuring data center efficiency. It is calculated by taking into account the total facility energy and dividing it by the IT equipment energy. Therefore, the resulting ratio provides the effective power overhead for a unit of IT load (The Green Grid, 2012).

IT equipment energy includes the energy associated with the IT equipment (compute storage, network equipment, etc.) and supplemental equipment (KVM switches, monitors, and workstations/ laptops used to monitor and control the data center). Moreover, total facility energy includes all IT equipment energy mentioned above plus everything that supports the IT equipment using energy, such as power delivery components (UPS systems, PDUs, batteries, etc.), cooling system components (CRAHs, CRACs, DX units), and other miscellaneous component loads (The Green Grid, 2012).

As an industry tool for measuring infrastructure energy efficiency, PUE provides a way to determine:

- opportunities to improve a data center's operational efficiency
- how a data center compares with similar data centers
- if the data center operators are improving designs and processes over time
- opportunities to repurpose energy for additional IT equipment
- a design target or goal for new data centers (The Green Grid, 2012).

Carbon usage effectiveness (CUE)

CUE is the second metric (along with PUE) in the family of xUE metrics designed to help data center community better manage their data centers. It is used to address carbon emissions associated with data centers operations. Furthermore, CUE is defined as total CO_2 emissions caused by the total data center energy divided by the IT equipment energy. The units of the CUE metric are kilogram of carbon dioxide per kilowatt-hour. The total data center energy is defined as the average energy used over a year measured at the point of utility hand-off-the-energy that is dedicated solely to the data center. The IT equipment energy stands for the equipment energy over the year that is used to manage, process, store, and route data within data center. Accordingly, the total CO_2 emissions component includes the CO_2 emissions from local and energy grid-based energy sources, which will be determined for the actual mix of energy delivered to the site (natural gas, diesel fuel, etc.) (The Green Grid, 2010).

Ultimately, CUE provides a way to determine:

- opportunities to improve data center's sustainability
- how a data center compares to similar data centers
- if the data center operators are improving designs and processes over time
- opportunities for the consideration of renewable power sources
- tradeoffs in energy efficiency strategies by comparing total CUE under various use scenarios, operating conditions, etc. (The Green Grid, 2010).

Water usage effectiveness (WUE)

WUE represents the third metric in the family of xUE metrics. It is designed to address water usage in data centers. WUE is defined at high level as the annual water usage divided by the IT equipment energy. The units of the metric are liter per kilowatt-hour. Besides the total data center energy component and total IT energy components, annual water use component includes all water used in the operations of or for the data center, which includes humidification, water consumed for cooling the data center and IT equipment, and the water used in the production of energy (The Green Grid, 2011).

In summary, WUE provides a way for driving optimization of an operational site's water use by:

- reducing IT energy use, thereby reducing cooling demand, thereby reducing water consumption
- ensuring that the humidity control system is optimized and the data center is running at the low end of recommended guidelines for humidity
- optimizing cooling tower operations to increase cycles of concentration
- implementing all appropriate airflow management strategies to improve cooling efficiency
- operating the data center at or near the recommended upper limit for temperature, as this will allow warmer chilled water and require less evaporation of water to produce it

(The Green Grid, 2011).

Sustainability metrics in practice

The implication of sustainability metrics proved to be significant for Google's data centers in order to improve energy efficiency and reduce overall emissions. In order to address one of the biggest challenges of all – climate change, Google began applying PUE to operate their data centers more efficiently. By simulating the recommended actions from the PUE model Google was able to consistently achieve a 40 percent reduction in the amount of energy used for cooling, which equates to a 15 percent reduction in overall PUE overhead after accounting for electrical losses and other non-cooling inefficiencies (Evans & Gao, 2016).

Historically, the PUE for average data center has been ebarrassingly poor. Malone and Belady (2006) in their study suggest that 85% of data centers were estimated to have a PUE of greater than 3.0, which means they consumed twice as much power as the actual computing load. Moreover, only 5% had PUE of 2.0 or better (e-Infranet, 2014).

According to Google, their comprehensive approach to measuring PUE include all of their data centers around the world which performance is continualy measured throughout the year. Since Google first disclosed their efficiency data in 2008, they have made continual improvements through PUE as a framework to optimize efficiency. By applying PUE Google's data centers managed to become one among most efficient in the world with one of the lowest PUE ever produced (Google, 2018).

Furthermore, there are many examples of the largest data center operators making significant strides in cutting their water use thanks to development of WUE metric, which extends its focus on efficiency beyond power. By using WUE as an approach, companies such as Facebook, Microsoft and Google managed to rethink their water treatment plant infrastructure to reuse the water in order to reduce the impact of their data centers on the environmental and local community as well to support recycling waste water to cool servers housed in the facilities. According to Uptime's study (2013), 34% of tech companies are already collecting water usage data (Miller, 2012).

Lastly, Cisco IT managed to met a 25% greenhouse gas reduction goal in 2012 by taking the CUE to reduce carbon emissions of their data centers. This was accomplished by embedding sustainability criteria into Cisco's supplier business scorecards what enchanced company's visiability to supplier activity while at the same time driving greater accountability for environmental and labor practices (Alger, 2013).

Short summary of sustainability metrics

Ideally, the metrics and processes established to address data center sustainability will help companies first determine if an existing data center can be optimized before moving ahead with a new data center. For this reason, metrics such as PUE, CUE and WUE are emerging as extremely important considerations in the design, location, and operation of data centers in the future (The Green Grid, 2011).

The combination of PUE, CUE, and WUE enables data center operators to assess important sustainability aspects in their data centers, compare the results, and determine if they need to make any energy efficiency and/ or sustainability improvements (The Green Grid, 2011).

Although all three metrics completely cover the operations of data center, they are not able to cover the full life-cycle environmental burden of the data center and IT equipment since that would make them far too difficult to measure, calculate or use (The Green Grid, 2011).

Accordingly, these metrics have positive effects on the industry, and it is a big opportunity for the industry to rally around them. Finally, the Green Grid recommends the use of the PUE, CUE, and WUE, with the understanding that these metrics would be refined in the future (The Green Grid, 2011).

Performance measurement and resource usage

Since resources are always limited, they need to be planned, scheduled and utilized cautiously. Therefore, performance measurement of the resources is substantial for learning the lessons needed for the effective resource management and implementation of preventive actions for future projects (Gundblach, 2013).

For instance, *Planning Effectiveness* (quantity of planned resources/ quantity of resources actually utilized) should be close to 1. If it is more than 1, that indicates that the project was over-planned, and, vice versa, if it is less than 1 then the project was under-planned. Likewise, it can be inferred that the project execution was excellent if the aforementioned metric was more than 1, and if the metric was less than 1, the project execution was poor (Gundblach, 2013).

Similarly, *Scheduling Effectiveness* (total number of resources/ number of resources released according to schedule) indicates that if the result is close to 1, the company did well. However, if it is more than 1, the project was not effectively scheduled. As mentioned before, it can be inferred that the project execution was poor if the above metric is more than 1 (Gundblach, 2013).

Moreover, resource utilization can be measured using *Utilization Effectiveness* (total clock hours available for project execution/ total hours actually utilized). Again, the above metric should be close to 1. If it is more than 1, the project did not effectively utilize the resources, and as before the project utilization was poor. Since it is impossible to utilize 100 percent of the clock hours available during the period of a project execution (absenteeism, equipment breakdown, etc.), the organization would have the norm for this metric and results could be compared with that norm in order to draw meaningful conclusions (Gundblach, 2013).

Optimization of resources, as applied to data centers, means always having the right amount of resources, to cost-effectively enable the business use of those data centers (Data Center Knowledge, 2017).

In addition, right resourcing implies, to get the data center job done without wasting money. One could optimize any given data center resource by measuring resource utilization; for example how busy a Central processing unit (CPU) is, and then make considered determination of what level was sufficiently busy to be upgraded or extended, or sufficiently non-busy to authorize consolidation. This approach was used, and proved to be useful, for everything from CPUs, memory and other server metrics, to things such as power consumption, where metrics like PUE were created and applied (Data Center Knowledge, 2017).

Accordingly, the increasingly rich metrics embedded in server chipsets could open new possibilities. Therefore adoption of *Application Performance Management* (APM) solutions that measure how much business work is being accomplished and how responsively, became one of the key metrics of today's data centers. Besides, researchers suggest that data center cost optimization through metrics such as *dollar-per-watt*, *power-per-transaction*, *performance-per-watt*, etc., could provide details about the actual operating expenses of running the data centers. In other words, the closer the data center get to complete instrumentation of important metrics, the lower the associated cost will be to successfully deliver those business services, and more efficient data centers would become (Data Center Knowledge, 2017).

Finally, hyper-scale players like Google, Facebook and Amazon have managed to achieve over 60 percent utilization by transforming themselves from traditional data centers to software-defined infrastructure (SDI). Not only that resulted in gigawatt-scale reductions in global IT load, but also delivered business value instead of wasting resources (Walker, 2016).

Chapter IV. Conclusion, policy and limitations, and author's reflection

4.1. Conclusion

After analyzing PMS, and in which way they can integrate sustainability within data center's corporate strategy, it can be argued that it is possible to rethink PMS to integrate environmental and societal issues with data center's business performance.

To summarize, all among the analyzed PMS models have the ability to adapt to the data center's needs, and to incorporate sustainability within data center's corporate strategy or business activities. However, not all of these models are suitable to communicate measures and do not provide guidelines for effective performance measurement. Also, some tend to measure environmental and social performance through stakeholder satisfaction despite it does not show where the value comes from and how the relationship between the objectives can be strategically important. Examples of such models are the Performance Prism and the EFQM Excellence Model, which are rather used to assist performance measurement selection within a company, since they are not strategic management tools. As such, the mentioned models are not of much use for data centers since they are not able to fully support their sustainability from a strategic point of view.

Furthermore, BSC and ABC should be the models considered for implementation in a data center. Both of the models are able to provide data centers with the multiple levels of analysis, balanced image of company's performance, and right set of measures. In addition, the models like BSC and ABC are proven to be effective in communicating measures as well as identifying causes and effects to help managers better understand where to apply attention in order to improve the company's performance. Also, both models are widely used in practice and are implemented by thousands organizations in various sectors so far, and will continue to prove themselves useful as a strategic management tools. Since data centers can be put into context of large company entities, it can be argued that they are likely to engage multi-dimensional and integrated PMS.

In order to enable data center's managers, operators, and designers/ engineers to determine energy efficiency and sustainability of their data centers, the Green Grid Association recommends the use of sustainability metrics such as Power usage effectiveness (PUE), Carbon usage effectiveness (CUE), and Water usage effectiveness (WUE). Accordingly, these metrics have positive effects on IT industry since they are able to provide a way to determine opportunities to improve data center's sustainability, compare results to similar data centers, and design target and goals for new data centers.

Large data center operators such as Google, Facebook, Microsoft and Cisco IT have already experienced the benefits of applying sustainability metrics as their implication resulted in a significant decrease in amount of energy required for cooling, support of waste water reuse and reduction of greenhouse gas emissions, as confirmed by official statistics.

Besides sustainability metrics, it is also important to mention performance measurement of the resources through Resource utilization, Application Performance Management (APM) solutions, and metrics for data center cost optimization such as dollar-per-watt, power-per-transaction, and performance-per-watt, which lower data center operating costs, and participate in enormous reductions of global IT load, as shown in the example of Google, Facebook and Amazon.

In order to answer the main question: "How can PMS contribute to data center's sustainability?" - the study suggests that PMS frameworks such as BSC and ABC can provide the possibility to measure IT performance and improve problem areas as well as strengthen data centers' monitoring and capacity planning. Since both PMS models are able to integrate sustainability within data center's corporate strategy - aligned with the appropriate sustainability metrics such as PUE, CUE and WUE, and appropriate performance measurement of the resources and cost optimization metrics, while used in a combination with other PMS frameworks or alone - they should help data center's managers, operators and designers/ engineers better understand social and environmental impacts of their data centers, as well as allow them to maximize operational efficiency and reduce negative impact on resources and environment.

4.2. Policy and limitations

Although this study lacks comprehensive literature about PMS application in data centers', the findings suggest that PMS could integrate sustainability within data center's corporate strategy.

The aim of this study is to answer the question: "How can PMS contribute to data center's sustainability?". This study provides an overview of PMS models, techniques and methods to integrate sustainability as a main part of data center's corporate strategy, and describes possible solutions to improve data center's sustainability and performance. Therefore, data center's managers, operators, and designers/ engineers can use this study for further improvements of data center's operations.

Author's recommendation for further investigation is to examine the implementation of other KPI's regarding data center's performance, network, storage, security, etc., to provide data center's operators with the ability to monitor to which extent data centers are sustainable more efficiently.

Also, it would be beneficial if more researches were done on applying PMS models specifically on data centers so data center's managers, operators and others involved could be more effective in decision-making and provide better management within a data centers in the future. Finally, the latest recommendation is to additionally investigate the correlation between PMS and usage effectiveness. In other words, is there a possibility for the data centers to gain on usage effectiveness without use of any form of PMS?

4.3. Author's reflection

Although numerous researches shows that companies which are using PMS achieve better organizational results, in practice there are not many examples of their use. Moreover, to choose an adequate PMS is a complex task and growing number of new models for measuring organizational performance does not make it any easier. Many authors often point out only advantages of certain models while little attention is paid to their disadvantages. Besides, guidelines for practical application of PMS are not sufficiently developed.

Nevertheless, I am thankful for the experience gained through writing of this paper since I was able to deepen my knowledge about PMS and learn a lot about how they can benefit organizational performance, sustainability, and thus the overall economy.

What I would do differently in case I have to write the final paper again is that I would focus on rather two PMS models such as BSC and ABC while doing a comprehensive analysis, and give more attention to the possible solutions to improve data center's sustainability instead of investigating various PMS models to integrate sustainability into a company's corporate strategy. This way, the thesis itself would be much more practical for the reader to absorb, as well as easier to complete.

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Appendix 1

Short review of other Performance Measurement models, frameworks and techniques

Except of the mentioned PM systems such as the BSC, the Performance Prism, the EFQM Excellence Model, and the ABC, there are also a few competing techniques in the literature worth to mention such as: The Performance Measurement Matrix (PMM), The Performance Measurement Questionnaire (PMQ), The Results and Determinants Framework, The Cambridge Performance Measurement Designing Process, The Pyramid of Organizational Development, The SMART Performance Pyramid, Kanji Business Excellence Measurement System, Integrated Performance Measurement System (IPMS) Reference Model, and Dart Boards and Clovers, among others.

The Performance Measurement Matrix (PMM)

The PMM was first-time introduced by Keegan (et al, 1989). It integrates financial and non-financial internal and external perspectives of business performance. The main strengths of PPM are its simplicity and integrated structure. However, PPM include a of structure and detail, particularly in relation to making the links between different business dimensions more explicit, as in the BSC (Bititci, 2015).

The Performance Measurement Questionnaire (PMQ)

The PMQ is a decision tool for managers developed by Dixon (et al, 1990). It is a structured questionnaire that audit compatibility of a company's performance measures in relation to its improvement aims and objectives. Moreover, the questionnaire analyses alignment, congruence, consensus and confusion – helping maintain consistency between the organization's strategy, improvement actions and measures. The PMQ differs from other models, frameworks, and techniques as it does not attempt to provide a framework for designing a PMS rather it is a tool for auditing the appropriateness of a PMS (Bititci, 2015).

Appendix 2

The Results and Determinants Framework

The results and determinants framework was developed by Fitzgerald (et al, 1991). It has a structure composed of six performance dimensions classified under two categories: results and determinants. The results category covers financial and competitiveness-related performance measures (lagging indicators) while the determinants category includes performance measures for service quality, flexibility, resource utilization and innovation (leading indicators) (Bititci, 2015).

The Cambridge Performance Measurement Designing Process

The Cambridge Performance Measurement Designing Process was developed by Neely (et al, 1996) in order to improve the design of performance measurement systems. It integrates all internal, external, financial and non-financial elements with a strategy to create coherent PMS. Also, the framework can assist with identifying conflicting performance measures while maintaining a balance between external and internal measures (Bititci, 2015).

Integrated Performance Measurement System (IPMS) Reference Model

The IPMS reference model was developed by Bititci (et al, 1997). It was created to quantify and model relationships between performance measures. This system comprises both a reference model and an audit method. Further, the model integrates stakeholder requirements with performance measures through the entire organization; external monitoring and competitive positioning; key business processes and associated performance measures. The model also includes normative planning and active monitoring through the usage of leading measures (Bititci, 2015).

Appendix 3

The Pyramid of Organizational Development

The Pyramid of Organizational Development is developed by Flamholtz (1995). It is a model that links organizational capabilities (culture, system and resources) to success in the market using following factors: corporate culture, management systems, operational systems, resource management, products and services, and markets. Moreover, as a model, it is much broader than PMS, which it incorporates as a management system (Bititci, 2015).

The SMART Performance Pyramid

The SMART Performance Pyramid was proposed by Cross and Lynch (1992). According to Tangen (2004), the main goal of the performance pyramid is to connect through organization's strategy with its operations by translating operations from the top down (based on customer priorities) and measures from the bottom up (Spickova & Striteska, 2012).

Furthermore, the performance pyramid contains four levels of objectives that affects organization's external effectiveness and, at the same time, its internal efficiency. First level of the pyramid is engaged in defining an overall corporate vision, which is then separated into individual business unit objectives. At the second level of pyramid are set short-term targets (e.g. of cash flow and profitability) and long term goal of growth and market position (e.g. market, financial). The third level contains day-to-day operational measures such as customer satisfaction, flexibility, productivity). Lastly, the fourth level includes four key indicators of performance measures: quality, delivery, cycle time and waste (Spickova & Striteska, 2012).

Strong points of the SMART Performance Pyramid are that it attempts to integrate corporate objectives with operational performance indicators, and manages performance measurement strategically. On the other hand, the main disadvantages of the pyramid are that it does not provide any mechanism to identify key performance indicators. It also fails to specify the form of measures, and, finally, it does not specifically integrate the concept of continuous improvement (Spickova & Striteska, 2012).

Appendix 4

Kanji Business Excellence Measurement System (KBEMS)

KBEMS is a model which consists from Kanji Business Excellence Model (KBEM) and Kanji Business Scorecard (KBS) and it is based on Critical Success Factors (CSFs), which correspond to the drivers of performance. The model was named after its author, Kanji, and it is formed by Part A and Part B of the PMS and these parts should be applied simultaneously, since they form a single and complementary view of organizational performance. KBEM is intended for the measurement of performance from the internal stakeholders' point of view, whereas the KBS evaluates the performance from the external stakeholders' perspective. Afterwards internal and external scores are incorporated to calculate the final organizational performance excellence index (OPI) that provides an aggregate measure of the organization's excellence in managing the CSFs. Moreover, KBEMS includes ten items in Part A (leadership, delight the customer, customer focus, management by fact, process improvement, people-based management, people performance, continuous improvement, continuous improvement excellence A) and five items in Part B 8organizational values, performance excellence, delight the stakeholders performance excellence B) (Spickova & Striteska, 2012).

Strong points of KBEMS are its multi-perspective view of performance, combining financial and non-financial measures and the assessment of different stakeholders. It is linked to the organization's values and strategies and based on the CSFs. In addition, the system highlights improvement opportunities and suggests some improvement strategies for the best possible use of the organization's resources. However, the weak points of this model are that it is mainly design for senior managers to provide them with an overall view of performance, and it does not offer explicit guidance on how to develop and implement a PMS effectively (Spickova & Striteska, 2012).

Appendix 5

Dart Boards and Clovers

Bonacchi and Rinaldi (2007) created a performance measurement system based on two managerial instruments called „Sustainability Dart Board“ and „Sustainability Clover“. The instruments are able to organize a set of primary and secondary measures, connected with stakeholder satisfaction, and to detect and articulate both win-win and trade-offs situations (Bonacchi & Rinaldi, 2007).

Dart Board provides a detailed measurement of sustainability. It is a geometrical space divided in three segments related to economic, environmental and social dimensions with indicators corresponding to particular stakeholder. Moreover, indicators are developed for three levels of results: the minimum value, the planned value, and the achieved value (Bonacchi & Rinaldi, 2007).

The second managerial instrument, Clover, allows for the understanding of connections between processes, stakeholder satisfaction and each single dimension that encompasses them, through a vertical and diagonal development between primary and secondary measures. Vertical development involves both the identification of a logical relationship between stakeholder satisfaction and primary measures, and the evaluation of the cause-and-effect relationships between primary measures and secondary measures. Diagonal development, in contrast, involves the secondary measures that, while connected by a vertical relationship to a given stakeholder satisfaction, could also affect the satisfaction of other stakeholders. In addition, the relationship between the primary measures informs how the stakeholder satisfaction can be influenced between them. In this case, Clover will show a diagonal relationship between two primary measures (Bonacchi & Rinaldi, 2007).

Appendix 6

$$PUE = \frac{Total\ Facility\ Energy}{IT\ Equipment\ Energy}$$

Power Usage Effectiveness (PUE) Equation

(source: https://datacenters.lbl.gov/sites/all/files/WP49-PUE%20A%20Comprehensive%20Examination%20of%20the%20Metric_v6.pdf)

$$CUE = \frac{\text{Total } CO_2 \text{ emissions caused by the Total Data Center Energy}}{\text{IT Equipment Energy}}$$

Carbon Usage Effectiveness (CUE) Equation

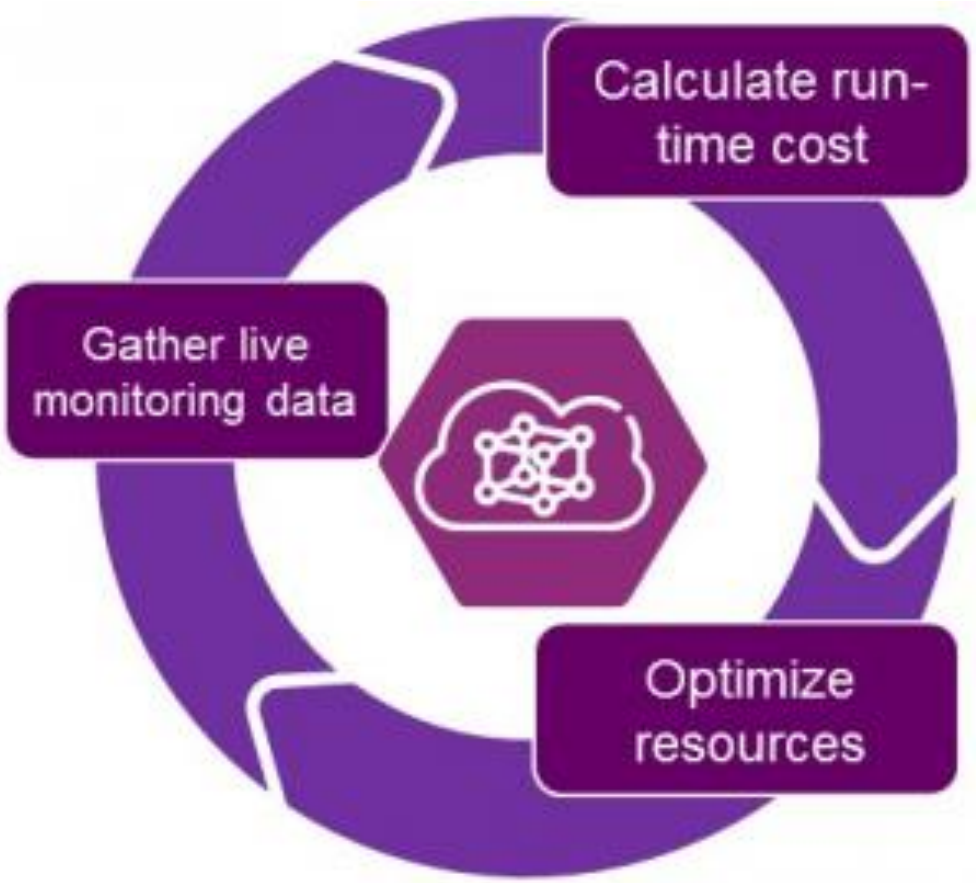
(source: http://tmp2014.airatwork.com/wp-content/uploads/The-Green-Grid-White-Paper-32-CUE-Usage-Guidelines.pdf)

$$WUE = \frac{\text{Annual Water Usage}}{\text{IT Equipment Energy}}$$

Water Usage Effectiveness (WUE) Equation

(source: http://tmp2014.airatwork.com/wp-content/uploads/The-Green-Grid-White-Paper-35-WUE-Usage-Guidelines.pdf)

Appendix 7



(source: https://www.ericsson.com/research-blog/todays-clouds-really-cheap/)