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**Corporate Performance Management
Considering Digitalization & Sustainability:
An Information Systems Perspective**

Dissertation

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For my parents.

“Our lives are not our own. We are bound to others, past and present, and by each crime and every kindness, we birth our future.”

[David Mitchell, Cloud Atlas]

Abstract

Megatrends such as digitalization and sustainability can implicate comprehensive changes for the business environment. Hence, organizations have to respond by adjusting their strategies and corporate objectives accordingly. As a consequence, this also has to translate into the installed corporate performance management instruments so that organizations can be steered properly. Therefore, the objective of this dissertation is to investigate corporate performance management by considering digitalization and sustainability from an information systems perspective. Specifically, it first studies foundations on performance measurement systems (PMS) as they build the basis for effective decision support. Second, this work examines how performance measures, an integral part of PMS, could be applied to the context of the stated megatrends.

Therefore, the first chapter illustrates the role of corporate performance management in general and introduces its associated instruments, namely PMS and performance measures. Furthermore, it depicts the megatrends along with its implications for organizations. The first chapter furthermore presents an outline of the objectives and structure of the dissertation. Finally, it portrays the four research papers included in this dissertation within the overall research context.

The second chapter serves as starting point for the succeeding work, as it provides general foundations on PMS, i.e. the first corporate performance management instrument. By means of the first research paper, a decision framework is being proposed for the consolidation of existing PMS. The reason is, that while there is an elaborate body of knowledge that deals with the initial design of PMS, very few approaches address the systematic consolidation of PMS. However, numerous PMS have been expanding over the years. Thus, they often contain more information than needed as well as irrelevant information, which impairs their function as decision support. Therefore, the paper first delineates informational and economic requirements relevant for effective information provision through PMS. On that basis, it develops a decision framework for the consolidation of PMS based on principles of multi-criteria decision analysis integrating these informational and economic requirements. The proposed framework is then evaluated based on a feature comparison, a prototype construction, and a real-world application.

The third chapter investigates how performance measures, i.e. the second instrument of corporate performance management, can be related to the megatrend of digitalization. Thereby, the focus is particularly on the increasing digital connectedness. That is because organizations are in need of suitable measures reflecting the specific attributes of social media applications to

evaluate, monitor, and thus manage their online activities such that they benefit from the interactions with the ever-increasing digitally connected customers. For that purpose, the second research paper is dedicated to the question of how to measure social influence in Online Social Networks (OSN). Targeting the most influential users in an OSN is one of the central challenges of viral marketing campaigns as by means of the diffusion of information via electronic Word-Of-Mouth (eWOM), many customers can be reached at small marketing costs. Consequently, a growing number of publications presents diverse approaches to measure the social influence of users and to identify the most influential users in OSN. For an overview of the applied methods, knowledge, and theories as well as to stimulate and guide further research at the interface of information systems and marketing literature, a structured literature search was conducted. The third research paper accounts for the current hype of organizations around company profiles, i.e. so called ‘fan pages’ in OSN. Thereby, the number of fans on a fan page established as a popular social media measure, which many companies strive to maximize today. By drawing on a Portfolio Selection Theory based model and real-world data, this paper suggests that, under risk-diversification aspects, it is economically more reasonable to use the ratio of fans to non-fans as a measure to manage a company’s customer portfolio.

The fourth chapter investigates performance measures in the context of sustainability. Today, much effort is put into the development of sustainability strategies, business case calculations, or disclosing the strategies along with predefined targets in sustainability reports. Organizations, however, still struggle with their implementation. As starting point to foster the lagging implementation, organizations have to ensure that the installed sustainability performance measures are properly pursued. In this context, researchers point out that the missing link to fuse sustainability with core business activities is the design of executive compensation packages. Hence, this research paper presents an empirical analysis of the executive compensation packages of 60 publicly traded companies listed on the US Dow Jones Industrial Average Index (DJIA) as well as on the German Stock Index (DAX) for the years 2009 and 2012. Thereby, it analyzes to what extent the executive compensation contracts are tied to sustainability targets of the environmental, social or (long-term) economic dimension.

Finally, the fifth chapter summarizes the key findings of this dissertation and concludes with opportunities for future research.

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Please note: References are provided at the end of each section and each research paper, respectively.

Index of Research Papers

This dissertation contains the following research papers:

Research Paper 1:

Grosswiele, L., Röglinger, M., Friedl, B. (2013). A Decision Framework for the Consolidation of Performance Measurement Systems. *Decision Support Systems*, 54(2), 1016-1029.

(VHB JOURQUAL 3: Category B)

Research Paper 2:

Probst, F., Grosswiele, L., Pfleger, R. (2013). Who will lead and who will follow: Identifying Influential Users in Online Social Networks - A Critical Review and Future Research Directions. *Business & Information Systems Engineering*, 5(3), 179-193.

(VHB JOURQUAL 3: Category B)

Research Paper 3:

Banz, M., Grosswiele, L., Huber, J., Probst, F. (2015). More Fans at any Cost? Analyzing the Economic Effects of the Ratio of Fans to Non-Fans in a Customer Portfolio Considering Electronic Word-of-Mouth. *Accepted with minor revisions for Journal of Decision Systems*.

(VHB-JOURQUAL 3: Category B)

Research Paper 4:

Grosswiele, L. (2015). Towards Corporate Sustainability: are Sustainability Performance Targets tied to Executive Compensation? Empirical Insights Based on Publicly Traded Corporations. *Submitted to Business and Society Review*.

(VHB-JOURQUAL 3: Category C)

I. Introduction

1. Motivation

For organizations being able to endure and thrive in a competitive, dynamic and complex business environment, it is vital to accomplish their strategic goals (FitzRoy et al., 2012; Kaplan and Norton, 2008). Consequently, steering an organization in line with its strategy and towards predefined objectives is a key managerial task (Hrebiniak, 2008; Pearce and Robinson, 2011). However, only “what gets measured, gets managed”, as Peter Drucker, a renowned management theorist, claims (Drucker, 1954). Hence, *corporate performance management* established as an essential means for translating strategic goals into results (Bititci et al., 2012; Brudan, 2010; Marchand and Raymond, 2008; Taticchi et al., 2012). That is because corporate performance management encompasses processes, systems, and measures that allow for evaluating, monitoring, and thus managing business activities to improve individual or corporate performance and business strategy execution (Ates et al., 2013; Eckerson, 2011; Rayner et al., 2006). The corresponding instruments convey performance-based information supporting decision making and managerial activities (Melnyk et al., 2014; de Waal, 2010), such as appraising an organization’s progress towards predefined objectives (Franco-Santos et al., 2012) and deriving corrective actions in order to achieve them (de Waal and Kourtiti, 2013; Kaplan and Norton, 2008). The provision and processing of decision-relevant performance information based on timely, complete, and accurate performance data and an supporting technological infrastructure is a central purpose of corporate performance management, which consequently has been subject to extensive research from an information systems perspective (Akma et al., 2010; Frolick and Ariyachandra, 2006; Galliers and Leidner, 2003; Kueng et al., 2001; Marchand and Raymond 2015; Nudurupati et al., 2011; Pidun and Felden, 2013).

However, it has been highlighted that the installed instruments of corporate performance management need to be continuously reviewed and adjusted if applicable, such as by the design of new measures (Ates et al., 2013; Cocca and Alberti, 2010; Melnyk et al., 2014). Specifically, it is important that these instruments are being adapted to changes in the business environment (Nudurupati et al., 2011; Taticchi et al., 2012; Yadav and Sagar, 2013). The reason is that, in order to cope with such changes, seize the opportunities of transformations and thus to remain competitive, organizations might need to adjust their strategic plans or delineated objectives, which in turn has to cascade down correspondingly to the instruments of corporate performance management (Kaplan and Norton, 2008). Only by a proper alignment, corporate performance

management can function effectively as decision support (McAdam and Bailie, 2002; Melnyk et al., 2014; Neely, 1999; Taticchi et al., 2012).

In the early 21st century, such profound changes in the business environment, which have implications also for corporate performance management, arise particularly from two megatrends of today's society. These will be discussed in detail hereafter. The term megatrend, coined by John Naisbitt in 1984, is a “long-term, transformational process with global reach, broad scope, and a fundamental and dramatic impact” (Vielmetter and Sell, 2014, p. 6). First, there is the rapidly proceeding *digitalization*, even referred to as the “digital revolution” (Bojanova, 2014; vor dem Esche and Hennig-Thurau, 2014; Vielmetter and Sell, 2014) and second, the society has an ever-increasing *sustainability awareness* and expectation (Lubin and Esty, 2010; Mittelstaedt et al., 2014; Tideman et al., 2012). Both developments are not entirely new as they undergo a progress for years – but today, their implications affect organizations with completely new intensity, speed and particularly reach. To properly respond to changes in the business environment implied by the digitalization and sustainability, organizations might adjust their strategic plans and define new objectives (Kaplan and Norton, 2008). As outlined above, this has to translate accordingly into effective instruments of corporate performance management. Corporate performance management can only provide appropriate decision support and serve as vehicle for strategy execution, if it considers potential adjustments in the business environment correspondingly.

The objective of this dissertation is therefore to investigate corporate performance management by considering digitalization and sustainability from an information systems perspective by means of four research papers. Thereby, the dissertation focuses on different instruments of corporate performance management as object of research. This section presents the subject of corporate performance management in general as well as its associated instruments, which will be analyzed in the subsequent sections. Also, the stated megatrends along with their implications for organizations are being portrayed. The next section extends these foundations on corporate performance management by discussing basics for effective decision support within the first research paper. On this basis, the second and third section are dedicated to more specifically investigate how corporate performance management instruments can be applied in the context of the stated megatrends by means of the remaining three research papers.

Performance Management, Measurement Systems, and Measures

As framing for the succeeding work, this subsection presents foundations of performance management and its related instruments, namely performance measurement systems and performance measures. These elements also represent research objects of this dissertation (see Figure 1). The dissertation's detailed structure will be discussed in section 3.

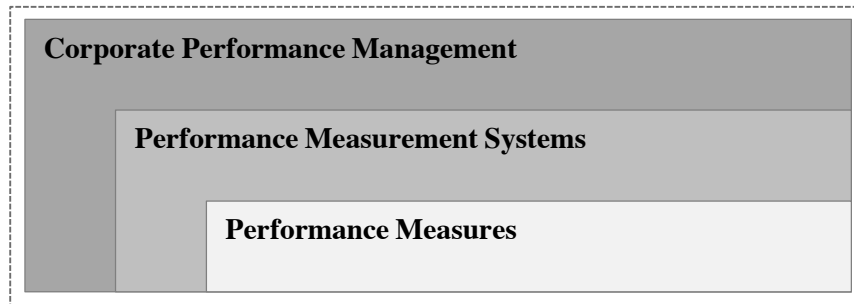


Figure 1: Structure of Corporate Performance Management and its Instruments - the Research Objectives of this Dissertation

First, the overarching field of research of this dissertation is corporate performance management. In general, performance management can relate to the individual (e.g. employees), team, process or corporate performance level (Brudan, 2010). Furthermore, the subject of performance is case-specific and depends on the actual question to be analyzed. This may encompass financial, customer, quality, social, or environmental aspects. This dissertation is not limited to a specific performance aspect, however it is dedicated to the overall corporate performance level and takes on a strategic decision-making focus. In line with Bititci et al., this work defines *corporate performance management* as (Bititci et al., 1997, p. 524):

“[...] the process by which the company manages its performance in line with its corporate and functional strategies and objectives.”

More specifically, corporate performance management allows for evaluating, monitoring, and thus managing business activities to improve corporate performance and business strategy execution (Ates et al., 2013; Eckerson, 2011; Rayner et al., 2006). *Performance* thereby can be defined following Lebas and Euske (2007, p. 68):

“[...] performance refers simultaneously to the action, the result of the action, and to the success of the result compared to some benchmark.”

In this context, it relates “[...] to the timely attainment of stated objectives within constraints specific to firm and to situation. Performance is therefore case specific and decision-maker specific” (Lebas, 1995, p. 29). The assessment of performance can aim for informational or motivational purposes (Franco-Santos et al., 2012). Over the last two decades, the focus of

performance information shifted from mere financial aspects to an integrative view balancing financial and non-financial performance dimensions (Akthar and Mittal, 2014; Marchand and Raymond, 2015; Yadav and Sagar, 2013). The corporate performance management process comprises several sub-processes such as target setting, forecasting, performance review, incentive compensation or the actual performance measurement (Brudan, 2010; Eccles, 1991; Frolick and Ariyachandra, 2006; McGee, 1993). Corporate performance management thereby highly depends on its core sub-process of performance measurement (Choong, 2014). Thereby, performance measurement builds the foundation for corporate performance management (Lebas, 1995). In other words, corporate performance management drives actions and ensures that targets are being achieved based on the results of performance measurement and evaluation (Brudan, 2010). Consequently, effective management needs support by proper measurement processes and systems.

This leads to the first research object of this dissertation, namely the corporate performance management instrument of *performance measurement systems (PMS)*. The understanding of PMS varies widely (Choong, 2014). Some authors describe PMS with respect to their role, such as Neely et al., who define PMS – today also referred to as contemporary PMS – as a “[...] balanced and dynamic system that is able to support the decision-making process by gathering, elaborating and analyzing information” (Neely et al., 2002). This perception of PMS as a kind of an information system is represented by many further authors (Bititci et al., 1997; Frolick and Ariyachandra, 2006; Kueng et al., 2001; Lynch and Cross, 1991; Marchand, 2008). Mostly, PMS are classified by their features (Franco-Santos et al., 2012). Franco-Santos et al. (2007) studied the key features of PMS based on an extensive literature review. This dissertation follows their quintessence and defines *PMS* as (Franco-Santos et al., 2007):

PMS comprise a set of performance measures as well as the supporting infrastructure enabling data to be acquired, collected, sorted, analyzed, interpreted, and disseminated.

The second research object of this dissertation is the instrument of *performance measures* – the ultimate carrier of the performance information and integral part of PMS. Performance measures can be defined as follows (Bourne et al., 2005; Kennerley and Neely, 2003; Neely, 2005):

Performance measures quantify the efficiency and/or effectiveness of the entity under investigation from a distinct perspective.

As stated above, over the last two decades, the performance focus shifted from a mere financial perspective to an integrative view through complementing traditional financial measures with non-financial operational and strategic measures of performance (Akthar and Mittal, 2014; Marchand and Raymond, 2015; Yadav and Sagar, 2013). As performance is also defined as the outcome of organizational activities, performance measures can be perceived as surrogates for these outcomes (De Waal, 2003).

As organizations today face the challenge to properly respond to the digitalization and sustainability megatrends, also these instruments of corporate performance management need to come under scrutiny.

The Megatrends Digitalization & Sustainability

The first megatrend of the rapidly proceeding *digitalization*, also referred to as “digital revolution”, leads to entire conversions of (existing) business models and value chain activities (Garrigos-Simon et al., 2012; Smits and Mogos, 2013; Wirtz et al., 2010). Organizations have no choice but to (re)position themselves in the competitive emerging digital business world (Berman, 2012; Kietzmann et al., 2012). The reason is that the digitalization changes almost every part of private and business life and thus transforms our society to such an extent as only the industrial revolution did befor (vor dem Esche and Hennig-Thurau, 2014). This dissertations builds on the following understanding of digitalization:

Digitalization is a major change process with enormous “disruptive power” that effects not only the area of information and communication, but also products, services and distribution channels (vor dem Esche and Hennig-Thurau, 2014). This is boosted by the heavily usage of a variety of digital technologies (Bojanova, 2014; Power and Phillips-Wren, 2011).

A Gartner study highlighted the four driving forces of social media, mobile computing, cloud computing, and information (“big data”) (Gartner, 2012). For instance, the world’s capacity to store, communicate, and compute information increased dramatically (Hilbert and López, 2011). This caused an explosion of the volume, velocity and variety of data being generated and stored (McAfee and Brynjolfsson, 2012) in every discipline and every aspect of daily life (Bennett et al., 2013). Furthermore, as of March 2015, there were 3 billion active internet users, more than 3.6 billion active unique mobile users – with 9 new users every second – and more than 2 billion active social media accounts (wearesocial.net, 2015). As a result, also customers become increasingly digitally connected among each other as well as with companies, such as via social media platforms (Culnan et al., 2010; Kietzmann et al., 2011). Particularly the

explosive growth of Online Social Networks (OSN), such as Facebook, which alone has grown to almost 1.39 billion monthly active users (Facebook, 2015), stimulated an extensive digital connectedness. Such an OSN can be defined in line with Boyd and Ellison (2013, p. 158) as a

“[...] networked communication platform in which participants 1) have uniquely identifiable profiles that consist of user-supplied content, content provided by other users, and/or system-provided data; 2) can publicly articulate connections that can be viewed and traversed by others; and 3) can consume, produce, and/or interact with streams of user-generated content provided by their connections on the site [usually via a so-called news feed].”

This increasing digital connectedness offers a variety of opportunities for organizations, such as for marketing (e.g. by leveraging eWOM for viral marketing campaigns), customer service support (e.g. installing online chat functionalities), or product development (integrating customers in the innovation process) (Culnan et al., 2010; Piller et al., 2012). While organizations heavily engage in social media, a key issue remains how to properly leverage the opportunities offered by social media (Yadav and Sagar, 2013). This largely depends on an organization's ability to make sound, targeted decisions as well as to evaluate, monitor, and thus manage its online activities and interactions with the new digitally connected customers. Consequently, their social media engagement has to be reflected by the supporting instruments of corporate performance management. To achieve a proper alignment, corresponding measures are required that account for the specific attributes of social media applications (Greenberg, 2010; Leeftang et al., 2014; Peters et al., 2013). *Hence, this dissertation investigates which performance measures are suitable to support decision-making in the context of digitalization, with particular focus on the increasing digital connectedness.*

The second megatrend of the growing *sustainability* awareness of today's society, which also largely affects the business environment, is invigorated by climate change, environmental disasters, scandals about miserable working conditions of employees, or the growing resource scarcity (Epstein and Buhovac, 2014). Consequently, customers, employees, (non-) governmental organizations (Collins et al., 2007; Kiron et al., 2012; Windolph, 2013), and increasingly also investors (Cooperman, 2013; Girerd-Potin et al., 2014) put tremendous pressure on organizations in their demand for sustainable business practices (Waddock, 2008). Besides the pressure of stakeholders, further drivers that led organizations to focus on sustainability are legislation, economic opportunities, and ethical motives (Bansal and Roth, 2000). In the course of this, the concept of *corporate sustainability* has evolved. It can be defined in line with Klettner et al. (2014, p. 146) as:

“[...] a commitment to operating in an economically, socially and environmentally sustainable manner.”

This refers to the so-called “triple bottom line”, a concept coined by Elkington, who postulates that corporations should focus “not just on the economic value that they add, but also on the environmental and social value that they add – or destroy.” (Elkington, 2004, p. 3). Furthermore, Elkington summarized that the sustainability transformation affects an organization’s “balance sheets (transparency, accountability, reporting and assurance), boards (ultimate accountability, corporate governance and strategy), brands (engaging investors, customers and consumers directly in sustainability issues) and business models (moving beyond corporate hearts and minds to the very DNA of business)” (Elkington, 2004, p. 15). Today, corporate sustainability established a substantial position on CEO agendas (Kiron et al., 2012) and it evolved as key element of corporate management principles (Hahn, 2011), which manifests its high awareness and acknowledgment by the business sphere. As a result, much effort is put into the development of sustainability strategies, business case calculations, or disclosing the strategies along with predefined targets in sustainability reports. Organizations, however, still struggle with their implementation (Klettner et al., 2014; Maon et al., 2009; Yuan et al., 2011). Particularly the alignment of the strategy, structure, systems, performance measures, and rewards is a major challenge for the effective implementation of corporate sustainability (Eccles et al., 2014; Epstein and Buhovac, 2014; Mackenzie, 2007; Searcy, 2012). As starting point to foster the lagging implementation, organizations have to ensure that the installed performance measures are properly pursued since this drives the achievement of predefined strategic goals. *Hence, this dissertation investigates how the implementation of sustainability performance measures can be supported by properly aligned corporate performance management processes.*

This dissertation therefore addresses the depicted challenges of effective corporate performance management considering digitalization and sustainability. The following section 2 outlines this dissertation’s objectives and structure. In section 3, the corresponding research papers are embedded in the research context and the fundamental research questions are highlighted.

2. Objectives and Structure of the Dissertation

The objective of this dissertation is to study corporate performance management considering digitalization and sustainability from an information systems perspective. As basis, it first investigates PMS for foundations on effective decision support. Second, it examines performance measures, as they are an integral part of PMS and the ultimate carrier of performance information in the context of the stated megatrends. Table I.1 depicts the dissertation's sub-objectives and its structure along with the enclosed research papers.

I Introduction	
Objective I.1:	Illustrating the role of corporate performance management, demonstrating the need for adapting its instruments to digitalization and sustainability and presenting central definitions
Objective I.2:	Outlining the objectives and structure of the dissertation
Objective I.3:	Embedding the included research papers into the context of the dissertation and formulating the fundamental research questions
II Foundations on Performance Measurement Systems (Research Paper 1)	
Objective II.1:	Delineating informational and economic requirements relevant for effective information provision through PMS
Objective II.2:	Developing a decision framework for the consolidation of existing PMS
III Performance Measures Relating to Digitalization (Research Paper 2 and 3)	
Objective III.1:	Synthesizing approaches to measure social influence and identify influential users in OSN based on a literature review
Objective III.2:	Deriving a research agenda on the identification of influential users by identifying research gaps
Objective III.3:	Proving the economic necessity to measure the ratio of fans and non-fans in customer portfolios under risk diversification aspects considering eWOM
IV Performance Measures Relating to Sustainability (Research Paper 4)	
Objective IV.1:	Highlighting the role of performance-related executive compensation for the implementation of corporate sustainability strategies
Objective IV.2:	Investigating the alignment of executive compensation with social, environmental and economic performance measures
V Summary and Future Research	
Objective V.1:	Summarizing the key findings of the dissertation
Objective V.2:	Identifying and highlighting areas for future research

Table 1: Objectives and structure of the dissertation

3. Research Context and Research Questions¹

This dissertation includes four research papers, which are embedded in the subsequent chapters. For an overview, this section relates each research paper to the dissertation's research context of corporate performance management (cf. Figure 2) and highlights the corresponding research questions.

Effective corporate performance management requires that the applied instruments are designed properly and adapted to changes in the business environment, where applicable. As delineated above, a central instrument of corporate performance management are PMS. As starting point, the first research paper therefore investigates PMS – regardless of a particular area of application – to provide the basis for effective decision support. In the course of this, the presented foundations of corporate performance management (cf. section 2) are extended. If essential PMS design issues are regarded, the specific area of application can be incorporated. As an integral part of PMS are performance measures, which are also the ultimate carrier of performance information and therefore the logical starting point for adjustments, the remaining three research papers specifically investigate how they can be applied to the context of digitalization, with particular focus on digital connectedness, as well as sustainability.

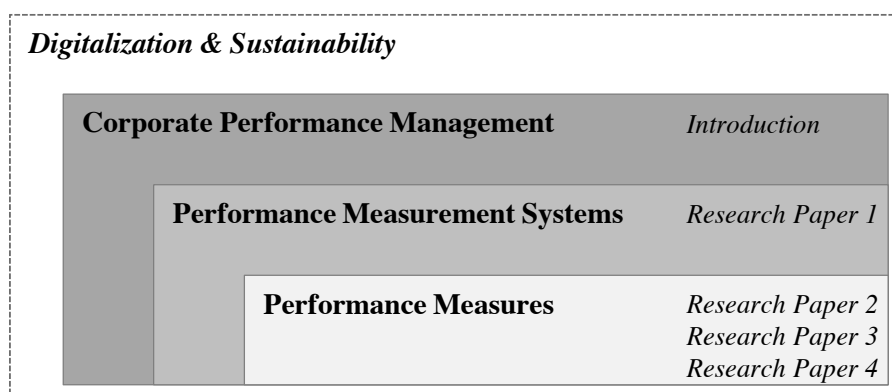


Figure 2: Focus of the Research Papers

Foundations on Performance Measurement Systems (Chapter II)

The first research paper “*A Decision Framework for the Consolidation of Performance Measurement Systems*” is dedicated to PMS, a central corporate performance management instrument. This paper investigates PMS – regardless of a particular area of application – to provide the basis for effective decision support and therefore the foundation for the specific reflections in the subsequent research papers. As managers are “drowning in data while thirsting

¹ All research papers included in this dissertation present slightly revised versions of the original publications for a consistent layout throughout the dissertation.

for information” (Neely and Jarrar, 2004, p. 502), the need for PMS increased over the last decade (de Waal and Counet, 2009). For effective information provision through PMS, however, they have to be designed properly. While several approaches deal with the initial design of PMS, only few address a systematic consolidation of PMS (see chapter II, section 2.3). Consolidation procedures are necessary as PMS have been subject to uncontrolled growth in recent years and thus accumulated an abundance of – even irrelevant or redundant – information. Yet, human information processing capabilities are limited (Duncan, 1980; Miller, 1956; Schroder et al., 1967). If these limits are exceeded, this may result in information overload (Iselin et al., 2010; Nudurupati et al., 2011), stress or loss of clarity (Bawden and Robinson, 2009) and thus even lead to reduced decision quality (Arnott and Dodson, 2008; Eppler and Mengis, 2004). Together with this informational perspective, one has to consider the economic perspective of information provision. Although information is not for free, costs are rarely taken into account in the context of PMS (Arnott et al., 2007; Johnston et al., 2002). Thus, the first research paper proposes a decision framework for the consolidation of existing PMS. Therefore, it first provides foundations relevant for effective information provision through PMS. On that basis, it develops a decision framework for the consolidation of PMS based on principles of multi-criteria decision analysis considering informational and economic challenges of information provision. The proposed framework is then evaluated based on a feature comparison, a prototype construction, and a real-world application. In the course of this, the following research questions are addressed:

- Which requirements have to be fulfilled by a (consolidated) PMS as well as by the consolidation process from an informational and economic perspective?
- Which measures enclosed in an existing PMS are sufficient to manage the fields of action under investigation at an adequate level of information processing complexity?
- Which existing measures and parts of the supporting infrastructure are worth their costs?
- How can these partially conflicting informational and economic objectives be integrated?

Performance Measures Relating to Digitalization (Chapter III)

The next two research papers study performance measures, the next central instrument of corporate performance management, considering digitalization with particular focus on the digital connectedness. That is as performance measures are the ultimate carrier of performance information and therefore the logical starting point for adjustments in line with changes in the

business environment such as due to the digitalization. As outlined above, the digitalization changes almost every part of private and business life and particularly the digital connectedness of our society proceeds rapidly and has enormous implications. Boosted by the explosive growth of OSN, also customers become more and more digitally connected with each other and with companies, which has large impacts such as on their brand or product awareness, information acquisition, or purchase behavior (Mangold and Faulds, 2009; Kurniawati et al., 2013). Customers can easily share and disseminate information and opinions about brands, new services or products via diverse OSN functionalities and by the spread of such electronic word-of-mouth (eWOM) they might thus influence other customers (Godes and Mayzlin, 2004; Hanna et al., 2011; Hill et al., 2006; Laroche et al., 2013). Already Katz and Lazarsfeld found that interpersonal word-of-mouth (WOM), today diffused digitally as eWOM via the Internet (Gil-Or, 2010; Goh et al., 2013), is the most important source of information for purchase decision making (Katz and Lazarsfeld, 1955). Henning-Thurau et al. defined eWOM as “[...] any positive or negative statement made by potential, actual, or former customers about a product or company, which is made available to a multitude of people and institutions via the Internet“ (2004, p. 39). This offers great potential for companies, particularly in the area of network-based or viral marketing (Gil-Or, 2010; Hill et al., 2006; Kaplan and Haenlein, 2010). Properly utilizing eWOM may improve a viral marketing campaign’s effectiveness, as customers trust eWOM more than marketer-generated content (Chen and Xie, 2008; Iyengar et al., 2011; Moon et al., 2013), as well as its efficiency, as by means of the diffusion of information via eWOM, many customers can be reached at small marketing costs (Kurniawati et al., 2013; Probst et al., 2013). While organizations heavily engage in OSN, it is still a key challenge to achieve the associated business objectives or targeted returns (Culnan et al., 2010; Fischer, 2009; Yadav and Sagar, 2013). Therefore, corporate performance management is an important means, if it properly aligned as depicted in section 1 (chapter I). A logical starting point is the design of suitable measures reflecting the specific attributes of the corresponding social media applications (Greenberg, 2010; LeeFlang et al., 2014; Peters et al., 2013). By means of specific measures, organizations can evaluate, monitor, and thus manage their online activities such that they benefit from the interactions with the new digitally connected customers.

For that purpose, the second research paper *“Who will lead and who will follow: Identifying Influential Users in Online Social Networks - A Critical Review and Future Research Directions”* is dedicated to the question of how to measure social influence in OSN. Targeting the most influential users in an OSN is one of the central challenges of viral marketing

campaigns (Aral and Walker, 2010) as by means of the diffusion of information via eWOM, many customers can be reached at small marketing costs (Kurniawati et al., 2013; Probst et al., 2013). Moreover, the dissemination of product or brand information via influencers might enhance the effectiveness of marketing initiatives, as customers trust eWOM more than marketer-generated content (Chen and Xie, 2008; Iyengar et al., 2011; Moon et al., 2013). Thus, this attracts attention of both, information systems and marketing researchers (Bonchi et al., 2011; Hinz et al., 2013; Katona et al., 2011). Consequently, a growing number of publications presents diverse approaches to measure the influence of users and to identify the most influential users in OSN. For an overview of the applied methods, knowledge, and theories as well as to stimulate and guide further research at the interface of information systems and marketing literature, a structured literature search was conducted. The identified articles were analyzed and synthesized with respect to the following research questions:

- How are influential users characterized in the context of OSN?
- Which approaches have been developed and applied to measure the influence of users in OSN?
- How have these approaches been evaluated and which implications have been derived?

The third research paper *“More Fans at any Cost? Analyzing the Economic Effects of the Ratio of Fans to Non-Fans in a Customer Portfolio Considering Electronic Word-of-Mouth”* accounts for the current hype of organizations around so called ‘fan pages’ in OSN. Fan pages are company profiles that enable (potential) customers to connect with a company and generate eWOM by creating comments, wall posts, or likes, which is then automatically pushed into the news feeds of all fans (Debatin et al., 2009; Gallagher and Ransbotham, 2010). In the course of this, the number of fans on a fan page established as popular social media metric (Sterne, 2010). Thereby, many companies strive for a maximum of fans (McEleny, 2011; O’Reilly, 2013), as recent studies suggest that the strong exposure of fans to eWOM can positively affect the resulting cash flows (Goh et al., 2013; Rishika et al., 2013). This, however, only holds true for eWOM with positive sentiment. In case of eWOM with negative sentiment, fans are also exposed to negative eWOM, whereas non-fans, who are not connected with the fan pages, are not affected as directly and intensively. Consequently, fans not only yield higher expected cash flows (than non-fans), but also the associated risks in terms of these cash flows’ volatility might be considerably higher. Therefore, corporations have to deliberately manage the proportion of fans in their customer portfolio. By drawing on a Portfolio Selection Theory based model and real-world data, this paper suggests the ratio of fans to non-fans as measure to account for

economic effects of eWOM on customer portfolios. Thus, the paper addresses to the following research questions:

- Is the ratio of fans to non-fans a feasible measure to economically optimize a company's customer portfolio?
- Is a sheer maximization of fans in a customer portfolio economically reasonable?
- Can prior findings suggesting that eWOM significantly influence the cash flows of fans while non-fans are less affected be confirmed?

Performance Measures Relating to Sustainability (Chapter IV)

The fourth research paper *“Is Executive Compensation Tied to Sustainability Performance Targets? Empirical Insights Based on an International Comparison of Publicly Traded Companies”* investigates performance measures considering the ever-increasing sustainability awareness. As stated before, the demand for sustainable business practices amplified tremendously over the last decades (Waddock, 2008). Hence, corporations nowadays largely engage in sustainability as response to the pressure of various stakeholders (Collins et al., 2007; Kiron et al., 2012; Windolph, 2013) or motivated by ethical considerations or economic opportunities (Bansal and Roth, 2000). Thereby, the concept of *corporate sustainability* has evolved, postulating the integration of economic, social and environmental aspects within core activities in a sustainable manner (Elkington, 2004; Klettner et al., 2014). Although much effort is put into pursuing sustainability strategies, organizations still struggle with their implementation and integration into central business activities (Klettner et al., 2014; Maon et al., 2009; Yuan et al., 2011). Studies highlighted that the alignment of strategy, structure, systems, performance measures, and rewards, i.e. key elements of corporate performance management, is important for an effective implementation (Eccles et al., 2014; Epstein and Buhovac, 2014; Mackenzie, 2007; Searcy, 2012). Additionally, a crucial role for transforming business operations towards sustainability is attributed to executives (Lindgreen et al., 2011; Spitzack, 2009). In this context, researchers point out that the missing link to fuse sustainability with core business activities is the design of the executive compensation packages (Berrone and Gomez-Mejia, 2009a; Klettner et al., 2014; Lindgreen et al., 2011) as “what gets measured gets attention, particularly when rewards are tied to the measures” (Eccles, 1991, p. 131). While previous research extensively investigated the relationship between performance-related compensation and certain financial and even non-financial measures (see e.g. Deckop et al., 2006; Devers et al., 2007; Jensen and Murphy, 2010; Ozkan 2009; Sigler 2011), empirical research with respect to its linkage to social, environmental and economic sustainability

dimensions is still in its infancy. Hence, this research paper presents an empirical analysis of the executive compensation packages of 60 publicly traded companies listed on the US Dow Jones Industrial Average Index (DJIA) as well as on the German Stock Index (DAX) for the years 2009 and 2012. In doing so, it deals with the following research questions:

- To what extent are sustainability targets of the environmental, social or (long-term) economic dimension considered within executive compensation contracts?
- What is the disclosure quality of sustainability targets tied to executive compensation?
- Does the corporations' conformity with the leading sustainability guidelines translate into executive compensation in form of a link with sustainability targets?

4. Individual Contribution to the Included Research Papers

The four presented research papers included in this dissertation were compiled in the following project settings: I developed research paper 1 (Grosswiele et al., 2013) in a research team with two co-authors. In this project, the team jointly developed the paper's basic conception. I was the designated leading author, as I largely conducted the detailed, written elaboration and was responsible for carrying out the following core elements of the paper: I analyzed and synthesized related literature to provide theoretical foundations and derive requirements for the PMS consolidation. Based on a structured literature search I reviewed existing approaches for the design and consolidation of PMS against these requirements and derived the research gap. Furthermore, I constructed an automated prototype in IBM SPSS, Microsoft Excel, and Visual Basic for Applications. To evaluate the decision framework based on real-world data, I prepared, conducted, and post-processed interviews at a strategic production planning department of an international company in the semiconductor industry.

Research paper 2 (Probst et al., 2013) was developed in a research team together with two co-authors. The team jointly conceptualized and elaborated the paper's content. Thus, I was involved in each part of the project: By reviewing fundamental literature from economics, marketing, and sociology beyond the context of OSN, I had a central role in delineating theoretical foundations on the identification of influential users in OSN. Besides elaborating on these foundations, I was responsible for designing and outlining the structured literature search. Together with the co-authors, I analyzed the 1,912 resulting articles, such that at least two of the paper's three co-authors screened each search result. Of the final set of 16 relevant articles, I thoroughly examined one third with respect to the paper's research questions. Based on this analysis, the team jointly synthesized the central findings and future research directions. Their

written elaboration was equally entitled to the three team members. As the co-author Florian Probst was the most experienced researcher at the time of writing the paper, contributed central ideas, and provided guidance for the written work, he was the designated leading author.

Research paper 3 (Banz et al., 2014) is based on a research project with three further co-authors. Overall, the co-authors contributed equally to the paper's conception and elaboration. However, as I was the most experienced researcher on-site at the time of writing the paper, I guided the entire paper process. Besides, I was particularly involved in the following parts: Based on insights stemming from my extensive work in course of research paper 2 on the theoretical foundations on social influence and existing research gaps in the context of OSN, I developed the paper's underlying idea. Moreover, I led the work on the foundations of eWOM in OSN, related work on economic effects of eWOM in OSN, and existing studies applying Markowitz's Portfolio Selection Theory in the context of Customer Portfolio Optimization. The team jointly worked on the design of the customer portfolio optimization model as well as its demonstration and evaluation. Thereby, the written work was also divided equally. Finally, with respect to the discussion of the model's findings and the overall conclusion, I was the responsible co-author for the creation of the content and its elaboration.

Research paper 4 (Grosswiele, 2014) was developed and written entirely on my own. Hence, I conceptualized the paper's idea and delineated related foundations. Furthermore, I conducted the data collection as well as the content-analysis of 60 annual reports and proxy statements of all corporations listed in the DJIA and the DAX. Based on the discussion of the analysis' findings, I derived implications for further research and practice.

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II. Foundations on Performance Measurement Systems

Research Paper 1: “A Decision Framework for the Consolidation of Performance Measurement Systems”

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Abstract: Numerous performance measurement systems have been expanding over the years. Therefore, they often contain more information than needed as well as irrelevant information. The consequences are high complexity in cognitively processing the enclosed measures and unnecessary costs for operating and maintaining the supporting infrastructure. Against this backdrop, we propose a decision framework that supports the consolidation of existing performance measurement systems such that information processing complexity and costs are balanced with the extent to which decision makers' information requirements are met and alignment with corporate objectives is achieved. We also report on the results of an evaluation based on feature comparison, prototype construction, and a real-world application.

1. Identification of and Motivation for the Research Problem

Whether for the implementation of corporate strategy, the continuous monitoring of corporate objectives, or the management of business units, performance measurement systems (PMS) are an accepted instrument for providing decision makers with information that enables them to take effective actions (Neely et al., 1995). Nevertheless, numerous PMS users indicate that they suffer from information overload (Iselin et al., 2010; Nudurupati et al., 2011). This is surprising because performance measures and PMS actually are intended to reduce complexity by abstracting from the real world (Lebas and Euske, 2007). In particular, PMS that have been subject to uncontrolled growth (i.e., the number of measures they enclose has been increasing over the years) are likely to contain more information than needed as well as irrelevant information. This phenomenon entails challenges for the information provision of decision makers that require intervention.

From an *informational perspective*, one has to consider the limitations of human information processing capabilities (Duncan, 1980; Miller, 1956; Schroder et al., 1967). Cognitively overstrained decision makers suffer from stress and loss of clarity (Bawden and Robinson, 2009), which in turn reduces decision quality (Arnott and Dodson, 2008; Eppler and Mengis, 2004, p. 326). As early as 1967, Ackoff recognized that misinformation is not only grounded in too much information, but also in irrelevant, redundant, and heterogeneous information – a problem that has intensified over the last decades (Ackoff, 1967; Farhoomand and Drury, 2002; Gantz et al., 2009; Lewis, 1996). Thus, the central challenge from an informational perspective is to answer the question of which measures enclosed in an existing PMS are sufficient to manage the fields of action under investigation at an adequate level of information processing complexity.

From an *economic perspective*, one has to consider that information provision is not free. The costs of information provision are all too often neglected in the context of PMS (Arnott et al., 2007; Johnston et al., 2002). A 1999 Hackett Group benchmarking study reported that companies spend an average of more than 25,000 person-days a year per billion dollars of revenue on measuring and reporting performance (Hackett Group Benchmarking, 1999). This figure may have decreased due to a more extensive automation of extraction, transformation, and loading (ETL) procedures, but it nonetheless corroborates the need to investigate PMS from an economic perspective. In doing so, the central challenge is to answer the question of which existing measures and parts of the supporting infrastructure are worth their costs.

While there is an elaborate body of knowledge that deals with the initial design of PMS, very few approaches address the systematic consolidation of PMS (see section 2.3). In the context at hand, consolidation refers to the decision about which measures enclosed in an existing PMS and which parts of the supporting infrastructure should be kept in order to provide sufficient information while at the same time reducing negative informational and economic effects. Against this backdrop, the paper addresses the following research question: *How can an existing PMS be consolidated considering the informational and economic challenges of information provision?*

To answer the research question, we adopt a design science research approach and propose a decision framework for PMS consolidation as artifact. As the decision framework is a model that enables the comparison of different consolidated PMS and shows characteristics of a method for guiding the process of PMS consolidation, the decision framework is a valid artifact type (March and Smith, 1995). In line with existing reference processes for design science research (Peppers et al., 2008), the present work covers the following phases: identification of and motivation for the research problem, objectives of a solution, design and development, and evaluation.

The remainder of this paper is structured as follows: In section 2, we introduce the foundations of PMS to delineate the problem context and unit of analysis. We also extract requirements for useful PMS from the literature that embody the objectives a solution to the problem of PMS consolidation should achieve (*objectives of a solution*). Using these requirements as an analytical lens, we discuss existing approaches to PMS design and consolidation to identify the research gap. In section 3, we sketch the principles of multi-criteria decision analysis, which serves as the research method for constructing the decision framework presented in section 4 (*design and development*). Section 5 reports on the results of feature comparison, prototype construction, and a real-world application (*evaluation*). The paper concludes in section 6 with a summary, implications, and limitations.

2. Domain Background and Related Work

2.1. Foundations of Performance Measurement Systems

Although PMS have been discussed extensively in the international literature on management accounting, operations management, and performance measurement for decades, no common definition has been established so far (Franco-Santos et al., 2007). Nevertheless, there is a consensus that PMS are an essential instrument of corporate performance measurement, which in turn is a component of performance management at large (Frolick and Ariyachandra, 2006;

Otley, 1999). Performance measurement aims to provide decision makers with information that enables them to take effective actions and evaluate whether a company is progressing in line with its strategy. Neely defines performance measurement as “the process of quantifying the efficiency and effectiveness of action” (1995).

With respect to what characterizes a PMS, Franco-Santos et al. classified existing definitions into different groups (2007). From an operations perspective, a PMS is a set of interdependent (performance) measures, also known as metrics, figures, or indicators (Neely et al., 2000). A PMS also includes the reporting process that gives feedback to employees on the outcome of actions (Bititci et al., 1997). From a strategic control perspective, PMS include the procedures to translate strategies into measures as well as the systems that provide the necessary information to challenge the content and validity of strategies (Ittner et al., 2003). From a management accounting perspective, PMS correspond to traditional management planning and budgeting (Otley, 1999). Franco-Santos et al. concluded that two major features make up a PMS: measures and the supporting infrastructure (2007).

Each *measure* enclosed in a PMS quantifies the efficiency and/or effectiveness of the entity under investigation from a distinct perspective and serves as indicator of overall performance (Bourne et al., 2005; Kennerley and Neely, 2002; Neely, 2005). A comprehensive discussion about the prerequisites for and the drawbacks of using measures as well as about the epistemic underpinnings of measures can be found in Strecker et al. (Strecker et al., 2011). It is common to distinguish between different, though not necessarily disjoint types of measures, such as financial and non-financial measures, leading and lagging measures, measures relating to different perspectives (e.g., financials, customer, business processes, or learning and growth), measures relating to different levels of abstraction (e.g., department-wide, company-wide, or industry-wide), or measures relating to phenomena from inside or outside the company (Eccles, 1991; Kaplan and Norton, 1996). It is important to note that measures in general do not exhaustively cover decision makers’ information requirements. They typically have to be complemented by qualitative information such as rumors, press releases, or external reports of competitors. Throughout this paper, we focus on those parts of the information requirements that refer to quantitative information provided by measures.

The performance measurement literature distinguishes between logical, empirical, and hierarchical interdependencies among measures (Küpper, 2008; Malina et al., 2007; Norreklit, 2000). Logical interdependencies result from definitions (e.g., $\text{profit} = \text{revenue} - \text{expenses}$) or mathematical transformation (e.g., $\text{return on investment} = \text{capital turnover} / \text{profit margin}$). Empirical interdependencies result from observing reality. They are either deterministic or

stochastic (e.g., higher prices probably lead to lower sales volume). Hierarchical interdependencies define ranked orders, which can be objective (e.g., annual profit = sum of monthly profits) or subjective (e.g., liquidity is more important than profitability). It is a widespread perception that PMS conform to a tree- or pyramid-like topology where a top measure (e.g., return on investment or economic value added) is decomposed by means of mathematical transformation into an objective hierarchy of lower-level measures. The DuPont System of Financial Control is probably the most popular example. A tree- or pyramid-like topology is feasible if mainly financial and lagging measures are used, and if performance is analyzed at a high level of abstraction. In business practice, however, financial and non-financial measures are used jointly in many cases, as are leading and lagging measures. Moreover, the lower the level of abstraction on which performance is analyzed, the more ambiguous logical and hierarchical interdependencies become. This results in a network-like topology where empirical interdependencies predominate. In practice, empirical interdependencies typically do not meet the requirements of causal relationships and cannot be derived from theoretically valid explanation models (Norreklit, 2000). Rather, they have to be interpreted as “is assumed to indicate” relationships and are stochastic in nature (Strecker et al., 2011). They can be revealed by analyzing historical data and have to be justified by consulting subject matter experts. Their strength can be quantified by means of measures of coherence as auxiliary quantities (e.g., correlation coefficients or coefficients of determination).

As for the *supporting infrastructure* of a PMS, there is no common understanding either. It can vary from very simplistic manual methods of recording data to sophisticated information systems and procedures of information provision that involve “data to be acquired, collated, sorted, analyzed, interpreted, and disseminated” (Kennerley and Neely, 2002), including the required human resources (Kerssens-Van Drongelen and Fisscher, 2004). Some authors put the supporting infrastructure and the PMS on the same level (i.e., PMS are interpreted as dedicated information systems with reporting and analysis functionality). Other authors regard the supporting infrastructure as technical and organizational means for implementing the conceptual parts of PMS and facilitating information provision (Burstein and Holsapple, 2008; Inmon, 2009; Marchand and Raymond, 2008). Independent of the concrete interpretation, it holds true that changes in the measures imply changes in the supporting infrastructure.

With these foundations in mind, we can narrow down how PMS are understood throughout this paper and what consolidation is about. We primarily focus on the conceptual parts of PMS, i.e., the enclosed measures and the interdependencies among them, because it is the measures that convey information to decision makers, not the supporting infrastructure. Without useful

content, the infrastructure does not create added value, no matter how sophisticated the IT-based reporting and analysis functionality or the procedures of information provision are. Consequently, the measures enclosed in a PMS should be the starting point for consolidation. We also consider PMS with a network-like topology. This is because such PMS are closer to reality. *Consolidation* then means that existing PMS come under scrutiny with respect to which of the measures they enclose should be kept. If one intends to incorporate the informational and economic perspectives of PMS consolidation, the effects of changing the measures of a PMS on the supporting infrastructure have to be considered as well. Throughout this paper, we interpret the supporting infrastructure as comprising sophisticated information systems and supporting procedures of information provision used for performance measurement. In the course of consolidation, it may happen that parts of the supporting infrastructure can be shut down or need not be executed anymore.

2.2. Requirements for Performance Measurement Systems

The literature has not only dealt with the features of PMS, but also with the requirements for a useful PMS. In this section, we compile the requirements for PMS from the literature. These requirements can be used to analyze existing approaches to PMS design and consolidation (see section 2.3), to guide the construction of the decision framework (see section 4), and to evaluate the decision framework (see section 5). Table 1 provides an overview of seven requirements. Each requirement is presented by means of an identifier, a description, and justificatory references. To extract the requirements, we first analyzed review papers related to PMS and performance measurement. Afterwards, we conducted a backward search for papers with a narrower focus (Webster and Watson, 2002). The results were merged with the results of a general literature search and condensed into requirements. Two researchers performed this process independently to increase reliability (Myers and Newman, 2007). We deliberately chose rather generic descriptions because the requirements should be applicable beyond PMS consolidation, and because we intended to avoid implicitly predetermining a concrete instantiation of the decision framework. Table 1 includes all identified requirements except for “comparability” (Caplice and Sheffi, 1995; Globerson, 1985; Maskell, 1991). This requirement was dropped as we are primarily interested in performance measurement within a single company, not in the comparison of multiple companies.

The requirements are structured along two dimensions: design product vs. design process and informational vs. economic perspective of PMS consolidation. As for the first dimension, requirements (R.1) to (R.4) refer to PMS as design products, whereas (R.5) to (R.7) emphasize

the corresponding design process. This is in line with design science research, in which it is common to distinguish between design products and design processes (Gregor & Jones, 2007; Hevner, March, Park, & Ram, 2004; Simon, 1996). In our understanding, design refers to both the construction of new PMS and the consolidation of existing PMS. As for the second dimension, requirements (R.1) to (R.3), (R.5), and (R.6) refer to the informational perspective of PMS consolidation. Requirement (R.4) relates to the economic perspective, and (R.7) is general in nature. We admit that a certain amount of ambiguity remains: the source papers were heterogeneous, not all papers formulated requirements explicitly, and our requirements are specified prosaically and derived based on our subjective interpretation. Nevertheless, the fact that each requirement is justified by multiple references allows us to infer their appropriateness. We therefore assume that an artifact that addresses these requirements makes a useful contribution to solving the problem of PMS consolidation.

	Identifier	Description	Perspective	Exemplary justificatory references
PMS as design products	(R.1) Coverage of the decision makers' information requirements	The measures enclosed in a PMS should enable the involved decision makers to manage the fields of action within their responsibility. Therefore, the measures should cover the decision makers' related information requirements, reflect the decision makers' objectives, and refer to the phenomena of interest. The PMS at large should constitute a balanced portfolio of different types of measures.	Informational	(Artley & Stroh, 2001; Caplice & Sheffi, 1995; Franco-Santos & Bourne, 2005; Gladen, 2008; Kaplan & Norton, 1996; Maskell, 1991; Wouters & Sportel, 2005)
	(R.2) Alignment with corporate objectives	The measures enclosed in a PMS should enable the involved decision makers to manage the fields of action within their responsibility in line with the company's strategy and objectives at a corporate level.	Informational	(Artley & Stroh, 2001; Caplice & Sheffi, 1995; Franco-Santos & Bourne, 2005; Globerson, 1985; Kaplan & Norton, 1996; Maskell, 1991; Wouters & Sportel, 2005)
	(R.3) Adequate information processing complexity	The complexity incurred for cognitively processing the information conveyed by the measures enclosed in a PMS should be adequate with respect to the provided information.	Informational	(Artley & Stroh, 2001; Bawden & Robinson, 2009; Caplice & Sheffi, 1995; Eppler & Mengis, 2004; Küpper, 2008; Reichmann, 2011)
	(R.4) Adequate costs for operations and maintenance of the supporting infrastructure	The costs incurred for operating and maintaining the supporting infrastructure necessary to report and analyze the measures enclosed in a PMS should be adequate with respect to the provided information.	Economic	(Arnott et al., 2007; Axson, 2010; Johnston et al., 2002)
Process of PMS design	(R.5) Consideration of interdependencies among measures	The interdependencies among the measures enclosed in the PMS should be considered during the process of PMS design and consolidation.	Informational	(Gladen, 2008; Globerson, 1985; Kaplan & Norton, 1996; Küpper, 2008; Reichmann, 2011)
	(R.6) Consideration of existing measures	The measures enclosed in existing PMS should be considered during the process of PMS design and consolidation.	Informational	(Artley & Stroh, 2001; Franco-Santos et al., 2007; Manoochehr, Rigas, & Fan, 2005; Maskell, 1991; Wouters & Sportel, 2005)
	(R.7) Systematic involvement of decision makers and subject matter experts	The decision makers who will use the PMS and the company's subject matter experts in performance measurement should be involved systematically during the process of PMS design and consolidation.	-	(Artley & Stroh, 2001; Caplice & Sheffi, 1995; Gladen, 2008; Küpper, 2008; Wouters & Sportel, 2005)

Table 1: Requirements for Performance Measurement Systems

2.3. Existing Approaches to the Design and Consolidation of Performance Measurement Systems

According to the previous elaborations, a PMS as a design product and its design process should comply with the outlined requirements. We therefore compare existing approaches using the requirements as an analytical lens to disclose the research gap regarding PMS consolidation.

Existing approaches were identified by means of structured database research based on the following search strategy: Papers had to satisfy the search expression *[("performance measurement" OR "performance management") AND ("design" OR "consolidation" OR "development" OR "evolution")]* for at least one of the search fields of title, abstract, or keywords. The first sub-expression localizes papers in the performance management domain at large. The second sub-expression sharpens the focus with respect to design and consolidation. The following scientific databases served as foundation: ACM Digital Library, AIS Electronic Library, CiteSeerX, EBSCOhost, Google Scholar, IEEEExplore, INFORMS, ProQuest, ScienceDirect, SpringerLink, and Wiley InterScience. We also considered the proceedings of the International and European Conferences on Information Systems. Assuming a cumulative research tradition, the search period was restricted to the years 2000 to 2011. Classifying publications in terms of search fields is a frequently used approach (Buhl et al., 2011), which leads to valid results if based on the previously mentioned search fields and a representative data basis (Steininger et al., 2009). From the authors' point of view, the data basis at hand is representative. To create a shortlist, each author analyzed the identified papers. A paper was sorted out if all authors agreed on its inappropriateness regarding the research question. Table 2 gives an overview on seven approaches to PMS design and consolidation that were identified and examined with respect to the requirements. We discuss the details below.

	PMS as design products					Process of PMS design	
	(R.1)	(R.2)	(R.3)	(R.4)	(R.5)	(R.6)	(R.7)
Bourne et al. (2000)	n/a	Postulated, but not specified within the approach	n/a	n/a	n/a	Postulated. Insights from a case study that presents an updated PMS	Involving executives through a workshop and assistance of experts
Jensen and Sage (2000)	Information requirements analysis with continuous “refinement”	Each measure is qualitatively attributed to predefined corporate objectives.	n/a	Decision rule: costs of reporting a measure should not exceed its “value”	n/a	“Gap analysis” that compares the actual PMS with a newly designed PMS to reveal necessary changes	Automated “organizational performance tracking and improvement analysis system” operated by decision makers
Medori and Steeples (2000)	n/a	Company success factors serve as basis for measure definition.	n/a	n/a	n/a	“Gap analysis” that compares the actual PMS with a newly designed PMS to reveal necessary changes	n/a
Neely et al. (2000)	Brainstorming to identify all required information, including comprehensiveness check	Postulated, but not specified within the approach	n/a	Cost-benefit matrix of measures	Postulated, but not specified within the approach	Ongoing reviews and updates by means of a review checklist	Continuous involvement of executives and assistance of experts
Röglinger (2009)	Postulated, but not specified within the approach	Each measure is qualitatively attributed to predefined success factors.	Aims at reducing the number of enclosed measures	Costs for customizing and maintaining reporting tools	Implicitly based on stochastic, empirical interdependencies	Determines optimal number of measures to which a current PMS should be reduced	Determination of model parameters by subject matter experts
Sousa et al. (2005)	n/a	Postulated, but not specified within the approach	n/a	n/a	Identification of interdependencies via a systems dynamics approach (case study)	Improving the actual PMS with the systems dynamics approach to identifying interdependencies	n/a
Wouters and Sportel (2005)	Postulated, but not specified within the approach	Postulated, but not specified within the approach	n/a	n/a	n/a	Case study on the development of a PMS considering existing measures	Group discussions and continuous involvement of executives

Table 2: An Analysis of Existing Approaches to PMS Design and Consolidation

- (R.1) *Coverage of the decision makers' information requirements*: This requirement is addressed by two approaches. Jensen and Sage (2000) proposed iteratively refining an initially compiled PMS until the decision makers' subjective information requirements are met. Neely et al. (2000) incorporated a comprehensiveness check where the results of a brainstorming session are validated against a list of predefined areas of interest to ensure that all the important areas for measurement have been covered.
- (R.2) *Alignment with corporate objectives*: All identified approaches postulate that the measures enclosed in a PMS should align with the company's objectives on a corporate level. Three approaches indicate how this could be achieved. Jensen and Sage (2000) required measures to be linked qualitatively with subjectively defined objectives. Medori and Steeples (2000) proposed deriving measures from predefined success factors. No further recommendations are provided about how this could be done. In the approach of Röglinger (Röglinger, 2009), each measure is qualitatively attributed to predefined success factors.
- (R.3) *Adequate information processing complexity*: Only the approach of Röglinger (Röglinger, 2009) explicitly considers the amount of information processing complexity induced by a PMS. In this case, information processing complexity depends on the number of measures enclosed in a PMS.
- (R.4) *Adequate costs for operations and maintenance of the supporting infrastructure*: This requirement is addressed by three papers. Jensen and Sage (2000) advised assigning costs for calculation and reporting directly to measures and considering only those measures whose "value" outweighs their costs. No specification is given for the term "value." Neely et al. (2000) proposed balancing each measure's costs against its benefits and choosing "high pay-off" measures only. They neither indicate how to determine a measure's benefits nor how to determine "high pay-off" measures. Röglinger (Röglinger, 2009) considered present-value payments for customizing and maintaining reporting tools.
- (R.5) *Consideration of interdependencies among measures*: Interdependencies among measures have been considered by Sousa et al. (2005) and by Röglinger (Röglinger, 2009). The first approach used a systems dynamics approach in a case study setting. The second approach implicitly considered stochastic, empirical interdependencies among measures when addressing the extent to which a PMS satisfies the decision maker's information requirements.

(R.6) *Consideration of existing measures*: All approaches except that of Bourne et al. (2000) consider existing measures during PMS design and consolidation. Jensen and Sage (2000) as well as Medori and Steeple (2000) suggested designing a PMS based on gap analyses and building on existing structures. To ensure the deletion of redundant measures and the implementation of novel ones, Neely et al. (Neely et al., 2000) proposed periodic reviews of existing PMS by means of a review checklist. This checklist is not disclosed. Röglinger (Röglinger, 2009) analyzed an existing PMS and determined the optimal number of measures to which this PMS should be reduced. Wouters and Sportel (2005) reported on the results of a case study about the development of a PMS that considers existing performance measures.

(R.7) *Systematic involvement of decision makers and subject matter experts*: Most of the identified approaches emphasize the participation of future “users” of the PMS and so-called “facilitators” during PMS design and consolidation. Jensen and Sage (2000), for example, involved executives as operators of a PMS design tool. Röglinger (Röglinger, 2009) reverted to subject matter experts to determine the values of input parameters. Three other approaches involve decision makers via different types of group discussions (Bourne et al., 2000; Neely et al., 2000; Wouters and Sportel, 2005).

The analysis of existing approaches to PMS design and consolidation revealed that each requirement is addressed by at least one approach. No approach, however, meets all requirements in an integrated manner. In addition, most approaches are qualitative in nature, which leaves considerable room for ambiguity and causes high manual effort. In our opinion, these arguments make up the overarching research gap. When it comes to single requirements, we feel that each requirement would benefit from additional research. Some requirements seem to be addressed particularly poorly. Bearing the negative consequences of information overload in mind, the fact that an adequate level of information processing complexity (R.3) is considered by only one existing approach motivates fundamental research on how to balance the information processing complexity induced by a PMS against its contribution to satisfying information requirements. With respect to adequate costs for operating and maintaining the supporting infrastructure (R.4), current papers neither reflect nor concretize a measure’s or PMS’ value, which makes it hard to determine whether a particular PMS justifies its costs. Furthermore, interdependencies among measures (R.5) are barely considered, though they are an important source for identifying redundancies.

Despite this research gap, the existing approaches to PMS design and consolidation provide valuable ideas and solution components to which we will return in section 4. Against this

backdrop, we intend to construct a decision framework that builds on existing approaches and contributes to closing the delineated research gap. It shall constitute an integrated and quantitative approach to PMS consolidation and cover the informational and economic perspectives of PMS consolidation.

3. Research Method

The decision framework presented in section 4 has been developed in line with the principles of multi-criteria decision analysis (MCDA). This is reasonable because the problem of PMS consolidation requires choosing from numerous alternatives based on multiple criteria. MCDA provides assistance in problem structuring, incorporating multiple criteria, resolving conflicts, and the appraisal of value judgments to support a deliberate and justifiable choice among the alternatives (Belton and Stewart, 2003; Keeney and Raiffa, 1993; Roy, 2005).

Cohon (2004) proposed a six-step procedure for solving multi-criteria problems: (1.a) identification and (1.b) quantification of the relevant objectives, (2) definition of decision variables and constraints, (3) data collection, (4) generation and valuation of alternatives based on the mathematical model, (5) selection of the preferred alternative, and (6) implementation of the selected alternative. Steps (1) and (2) are crucial for formulating the underlying mathematical decision model. Hence, they guide the construction of the decision framework. Steps (3) to (6) concern the actual application of the decision framework. We deal with steps (3) to (5) in section 5.4.

The decision framework is developed as follows: First, we outline the general problem setting and derive the objective system from the requirements for PMS as design products as introduced in section 2.2 (step 1.a). This is in line with Cohon, who requires objectives to be identified by searching “published material relative to the decision problem” (Cohon, 2004). Second, we operationalize the objective system by proposing a “statement of each objective as a mathematical function of decision variables” (Cohon, 2004) (step 1.b). This step draws from the requirements for the PMS design process outlined in section 2.2, the ideas and solution components of the existing approaches to PMS design and consolidation sketched in section 2.3, and from additional literature. Furthermore, we make non-trivial assumptions that influence the design of the decision framework transparent. These assumptions deliberately abstract from the real world to put a focus on the informational and economic perspective of PMS consolidation. Thereby, decision variables that represent the different consolidated PMS and constraints are formulated (step 2). Finally, the conflicting relationships among the objectives

are resolved by integrating the corresponding mathematical functions into an overall objective function (Figueira et al., 2005).

4. Decision Framework for the Consolidation of Performance Measurement Systems

4.1. Problem Setting and Objective System

We consider a company that consists of multiple business units. Each business unit is operated as a profit center and has its own management that makes decisions based on an existing PMS. We focus on a single business unit and introduce the following assumptions and definitions:

(A.1) The existing PMS of the business unit under consideration features a network-like topology. It encloses a set $M = \{m_1, \dots, m_k\}$ of thematically appropriate and metrically scaled measures m_i ($1 \leq i \leq k$). A consolidated PMS $M_{\text{cons}} \subseteq M$ is a subset of the existing PMS.

(A.2) The company's objectives at a corporate level are represented by a single metrically scaled top measure m_{top} .

A measure is thematically appropriate if subject matter experts agree that it can be reasonably used to manage the business unit under consideration. The top measure can be any market-oriented or internal profitability measure, such as earnings before interest or taxes or economic value added (Brealey and Myers, 2008).

In line with the requirements presented in section 2.2, the objective system of the decision framework comprises one objective for each requirement for PMS as design products, i.e., (R.1) to (R.4). This is because each consolidated PMS needs to be valued for the extent to which it satisfies these requirements. As decision makers typically strive for maximization or minimization in mono-criterion optimization settings, (R.1) to (R.4) translate into the following objectives:

(O.1) Maximize the coverage of the involved decision makers' information requirements.

(O.2) Maximize the alignment with the company's objectives at the corporate level.

(O.3) Minimize the information processing complexity.

(O.4) Minimize the costs for operations and maintenance of the supporting infrastructure.

Objectives (O.1) and (O.2) reflect positive informational effects. They tend to increase the number of measures enclosed in the consolidated PMS. Objectives (O.3) and (O.4) cover

negative informational and economic effects. They tend to reduce the number of measures enclosed in the consolidated PMS. Obviously, the relationships between (O.1) and (O.2) and between (O.3) and (O.4) are complementary. The relationships between (O.1) and (O.3) and between (O.1) and (O.4) are conflicting. The same holds true for (O.2) and (O.3) and for (O.2) and (O.4). Each objective has to be operationalized to allow integrated valuation of different consolidated PMS.

4.2. Operationalization of the Objectives

4.2.1. Positive Informational Effects

In this section, we provide the conceptual foundation and a mathematical function for operationalizing objectives (O.1) and (O.2). We treat these objectives simultaneously because both address positive informational effects and because the conceptual foundation of both objectives makes use of stochastic, empirical interdependencies (R.5).

It needs to be considered that the measures of the existing PMS do not in general address all of the decision makers' information requirements. As the decision framework only relies on existing measures (R.6), the best result achievable is that the consolidated PMS provides the same information as the existing PMS. Those parts of the decision makers' information requirements that are not addressed by the existing measures need to be covered by novel measures outside the decision framework. Against this backdrop, we rely on the extent to which a consolidated PMS M_{cons} covers the information provided by the existing PMS and use the existing PMS as a benchmark in order to operationalize objective (O.1). When determining this extent, we use a direct and an indirect contribution as proxy attributes (Röglinger, 2009). The direct contribution results from the fact that the values of the measures enclosed in M_{cons} are known and can be used directly for decision making. The more measures enclosed in M_{cons} , the higher the direct contribution. The indirect contribution results from the fact that there generally are stochastic, empirical interdependencies among the existing measures. This effect is figuratively referred to as "information overlap" (Dess and Robinson Jr, 1984). Thus, the missing direct contribution of non-enclosed measures can be compensated at least partially by indirect contributions based on the interdependencies among enclosed and non-enclosed measures. As decision makers judge measures as redundant where they expect strong interdependencies, this conceptual idea is corroborated from a business practice perspective (Lipe and Salterio, 2002). The stronger the interdependencies among enclosed and non-enclosed measures, the higher the information overlap and the indirect contribution. Thus,

perfect stochastic interdependencies with non-enclosed measures are treated as being as valuable as if these measures were enclosed (Röglinger, 2009).

When determining the extent to which a consolidated PMS M_{cons} aligns with the company's objectives at a corporate level (O.2), we draw an analogy to the concept of indirect contribution because the extent of alignment can be interpreted as the extent of information overlap between the measures enclosed in M_{cons} and the top measure m_{top} . The stronger the interdependencies among the enclosed measures and m_{top} , the higher the alignment. This is in line with the ideas proposed by Jensen and Sage (2000) and Medori and Steeple (2000). It is highly probable that perfect alignment with the objectives at a corporate level is never attained. Some reasons are that the existing PMS does not necessarily contain all relevant drivers of m_{top} , that activities of other business units influence m_{top} , and that interdependencies among the activities of various business units may become manifest as diversification effects.

We make the following assumption for operationalizing objectives (O.1) and (O.2):

(A.3) Between any measures $m_i, m_j \in M$ ($1 \leq i, j \leq k$ and $i \neq j$), and between any measure $m_i \in M$ ($1 \leq i \leq k$) and m_{top} , there may exist stochastic, empirical interdependencies that are (statistically) significant and can be justified by subject matter experts. All interdependencies are linear. Their strengths and polarities are constant during the period for which historical data for PMS consolidation is ascertained as well as during the period in which the consolidated PMS is used for decision support.

Linearity simplifies reality. Assuming it is not too restrictive as linear interdependencies are considered sufficient approximation for various economic settings (Libby, 1981; Markowitz, 1952). Moreover, measures usually only take values from a restricted interval within a relatively short period of time and if the business unit is rather stable. That is, even in the case of non-linear interdependencies, the loss of information due to linear approximation is tolerable if the period of time under consideration is not too long.

As we deal with interdependencies among numerous measures, we draw from the multivariate data analysis body of knowledge (Greene, 2003; Hair et al., 2006; Kleinbaum et al., 2008; Maddala and Lahiri, 2009). In line with assumption (A.3), we restrict ourselves to multiple linear regression where the strength of interdependency between multiple independent variables and a single dependent variable can be expressed by means of the coefficient of determination *R-square* (R^2). This coefficient represents the fraction of the dependent variable's variance that is explained by the independent variables. If one takes a non-enclosed measure $m_i \in M \setminus M_{\text{cons}}$

as a dependent variable and the measures enclosed in M_{cons} as independent variables, $R^2(M_{\text{cons}}, m_i)$ can be interpreted as the extent of indirect information that M_{cons} provides about m_i . If one takes m_{top} as a dependent variable, $R^2(M_{\text{cons}}, m_{\text{top}})$ represents the extent of alignment with m_{top} . Theoretically, one could also use an adjusted R-square whose value only increases if independent variables with a significant influence on the dependent variable are added to the regression model (Hair et al., 2006). The adjusted R-square, however, does not conform to the feature of monotonicity, which means that the positive informational effect either increases or remains unaltered if a given PMS is extended by an additional measure. Another reason for using R-square instead of the adjusted R-square is that the decision model covers negative informational effects due to an increased number of enclosed measures by means of objective (O.3).

In order to use multiple linear regression analysis in a methodologically well-founded manner, whether its premises are met has to be checked prior to each application (Greene, 2003; Hair et al., 2006; Maddala and Lahiri, 2009). A premise worth discussing separately is multicollinearity. While the decision framework focuses on identifying a consolidated PMS whose measures interdepend strongly with the non-enclosed measures and with m_{top} , we cannot exclude the enclosed measures interdepending among one another. Multicollinearity, however, does not constrict the model's validity because we are interested in the contribution of a PMS to covering the information provided by the existing PMS and in the extent to which it aligns with the company's corporate objectives. We are not interested in predicting any dependent variable's value or in separating the effects of individual enclosed measures. If a coefficient of determination is insignificant, it nevertheless has to be excluded from further calculations (e.g., by treating it as 0).

Based on these considerations, we propose to formalize the positive informational effects (*PIE*) of a particular consolidated PMS M_{cons} as follows:

$$PIE(M_{\text{cons}}) = \left[\lambda \cdot \frac{|M_{\text{cons}}| + \sum_{m_i \in M \setminus M_{\text{cons}}} R^2(M_{\text{cons}}, m_i)}{|M|} + (1 - \lambda) \cdot R^2(M_{\text{cons}}, m_{\text{top}}) \right] \cdot I \quad (1)$$

where $\lambda \in [0; 1]$ is a business unit-specific weighting factor,

$R^2(M_{\text{cons}}, m_i) \in [0; 1]$ is the coefficient of determination of a multiple linear regression with the measures of M_{cons} as independent and m_i as dependent variables,

$R^2(M_{\text{cons}}, m_{\text{top}}) \in [0; 1]$ is the coefficient of determination of a multiple linear regression with the measures of M_{cons} as independent and m_{top} as dependent variables, and

$I \in \mathbb{R}^+$ is the involved decision makers' subjective monetary equivalent of having all information provided by the existing PMS and perfect alignment with the company's objectives at a corporate level.

Equation (1)¹ can be interpreted in the order of its components: The first addend within squared brackets quantifies the direct and indirect contributions of M_{cons} to covering the information provided by the existing PMS. From a regression analysis perspective, the direct contribution can be formalized by the number of measures enclosed in M_{cons} , i.e., $|M_{\text{cons}}|$. This is because the variance of each enclosed measure is entirely explained by the measure itself. The indirect contribution is based on the stochastic, empirical interdependencies between the measures enclosed in M_{cons} and the non-enclosed measures $m_i \in M \setminus M_{\text{cons}}$. The strengths of these interdependencies are expressed by means of the coefficients of determination $R^2(M_{\text{cons}}, m_i)$. To calculate the total indirect contribution, the $|M \setminus M_{\text{cons}}|$ different $R^2(M_{\text{cons}}, m_i)$ values have to be summed up. This sum equals 0 if M_{cons} encloses no or all existing measures or if all non-enclosed measures are independent of all enclosed measures. It equals $|M \setminus M_{\text{cons}}|$ if the enclosed measures perfectly interdepend with all non-enclosed measures, which is rather unlikely in real-world settings. Adding the direct and indirect contributions and dividing their sum by the number of existing measures $|M|$ restricts the intermediate result to the interval $[0; 1]$. The second addend within squared brackets quantifies the extent of alignment with m_{top} , represented by $R^2(M_{\text{cons}}, m_{\text{top}})$.

¹ $\sum_{m_i \in M \setminus M_{\text{cons}}}$ is short for $\sum_{i \in I_{M \setminus M_{\text{cons}}}}$ where $I_{M \setminus M_{\text{cons}}} = \{j \in \{1, \dots, k\} | m_j \in M \setminus M_{\text{cons}}\}$; $|X|$ = number of elements included in X

The measures enclosed in two different consolidated PMS generally interdepend to different degrees with the respective non-enclosed measures and m_{top} . That is, while one PMS — say M_{cons}^1 — may highly cover the information provided by the existing PMS and hardly align with corporate objectives, another consolidated PMS — say M_{cons}^2 — may show the opposite properties. The problem of whether to select M_{cons}^1 or M_{cons}^2 can be resolved by weighting the involved components using a convex combination based on a business unit-specific weighting factor λ (Keeney & Raiffa, 1993). The value of λ needs to be determined outside the decision framework. A value close to 0 indicates that the involved decision makers attach more importance to managing the business unit in conformance with corporate objectives. A value close to 1 indicates that covering the information provided by the existing PMS is preferred. As both components of equation (1) and λ are restricted to the interval $[0;1]$, this holds true for any convex combination as well. The convex combination equals 0 if M_{cons} encloses no measures. It equals 1 if the measures enclosed in M_{cons} cover all information provided by the existing PMS and perfectly align with the corporate objectives. Finally, the interim result needs to be monetized to be commensurable with the negative economic effects covered by objective (O.4) (see section 4.2.3). This is achieved by multiplying it with the decision makers' subjective monetary equivalent I of having a PMS that captures the information provided by the existing PMS and that perfectly aligns with the company's objectives. One possibility for determining the value of I involves assessing the decision makers' average willingness to pay for such a PMS (Gibson, Arnott, Jagielska, & Melbourne, 2004; Samuelson & Marks, 2010).

4.2.2. Negative Informational Effects

The next objective to be operationalized is (O.3). Before decision makers are able to make decisions based on the measures enclosed in a consolidated PMS, they have to process the provided information. Thus, measures do not only cause positive information effects, but also information processing complexity. We operationalize information processing complexity by means of three proxy attributes. First, information processing complexity depends on the number of measures enclosed in the consolidated PMS (e.g. Duncan, 1980; Eppler and Mengis, 2004; Tushman and Nadler, 1978). Second, information processing complexity depends on how intuitively each individual enclosed measure can be understood. Third, information processing complexity depends on how heterogeneous are the measures enclosed in a PMS (Schroder et al., 1967).

Based on these considerations, we propose to formalize the negative informational effects (*NIE*) of a particular consolidated PMS M_{cons} as follows:

$$NIE(M_{\text{cons}}) = \left[\frac{|M_{\text{cons}}|}{|M|} \cdot \frac{\sum_{m_i \in M_{\text{cons}}} e_i}{\sum_{m_i \in M} e_i} \cdot \frac{u_{M_{\text{cons}}}}{u_M} \right] \cdot S \quad (2)$$

where $e_i \in \{1, \dots, n\}$, $n \in \mathbb{N}$ is the level of individual complexity assigned to m_i ,

$u_j \in \{1, \dots, |M|\}$ is the number of different units within M_{cons} or M ($j \in \{M_{\text{cons}}, M\}$), and

$S \in \mathbb{R}^+$ represents the decision makers' subjective monetary equivalent of coping with the information processing complexity caused by M

Analogous to the operationalization of objectives (O.1) and (O.2), we use the information processing complexity induced by the existing PMS as a benchmark. Equation (2) can be interpreted in the order of its subcomponents: The first factor within squared brackets quantifies the information processing complexity caused by the number of measures enclosed in M_{cons} as a fraction of $|M|$. The second factor captures the information processing complexity induced by the individual complexity of each enclosed measure. As a precise determination of the measure-specific complexity is challenging in business practice and may cause an inadequate elicitation effort as well as spurious precision, it seems appropriate to determine each measure's individual complexity approximately and in relation to other measures. We suggest defining several levels ($1, \dots, n$) of measure-specific complexity [e.g., 1 (simple), 2 (basic), 3 (average), and so forth] and assigning a specific complexity level $e_i \in \{1, \dots, n\}$ to each measure $m_i \in M$. To obtain the overall measure-specific complexity, we sum up the complexity levels e_i of all measures $m_i \in M_{\text{cons}}$ and divide the sum by the respective value for all measures from M . The third factor within squared brackets quantifies the information processing complexity caused by the heterogeneity of M_{cons} . We use the number of different units in M_{cons} to measure its heterogeneity. For example, a PMS that encloses measures expressed in currency unit, piece number, and fraction is more heterogeneous than a PMS whose measures are expressed in a single unit only. Therefore, the number of different units $u_{M_{\text{cons}}}$ featured by the measures enclosed in M_{cons} is divided by the overall number of different units u_M featured by the measures from M .

To get an overall understanding of the information provided by a consolidated PMS, not only the enclosed measures, but also the manifold relationships among them have to be processed (Sweller, 2003). Moreover, it has to be considered that human information processing capabilities are limited (Duncan, 1980; Miller, 1956; Schroder et al., 1967). Both arguments support an overproportional increase of information processing complexity. This course is

modeled by joining the complexity factors multiplicatively. As each coefficient's value is restricted to the interval $[0;1]$, this holds true for their product, which equals 0 if M_{cons} encloses no measures and 1 if M_{cons} encloses all existing measures. Analogous to the positive informational effects, the overall fraction needs to be monetized. This is done by multiplying it with the decision makers' subjective monetary equivalent S of coping with the information complexity induced by M . One possibility of determining the value of S relies on the concept of opportunity costs. In this sense, the amount of time the involved decision makers have to spend understanding and discussing the information provided by the existing PMS can serve as a proxy attribute (Samuelson and Marks, 2010). Based on an average daily rate and a daily working time, one could calculate the opportunity costs as an average subjective monetary equivalent (Röglinger, 2009).

4.2.3. Negative Economic Effects

In the preceding subsections, the informational perspective of PMS consolidation has been addressed. What remains is the economic perspective captured by means of objective (O.4), i.e., the costs of information provision resulting from operating and maintaining the supporting infrastructure. We distinguish three cost categories with different cost drivers and reference objects.

The first cost category refers to platform costs that are necessary for operating the underlying information systems (e.g., hardware, technical administration, or software licenses). Though it makes up the largest part of total costs in most cases, this cost category can be considered fixed and thus be neglected in the context of PMS consolidation because platform costs arise for any consolidated PMS and do not depend on their size or composition. Moreover, it is highly improbable that hardware and software will be deactivated in business practice based on the results of PMS consolidation. In line with the reporting costs mentioned by Jensen and Sage (2000) and the costs for customizing and maintaining reporting tools proposed by Röglinger (2009), the second cost category addresses costs for configuring, preparing, maintaining, and disseminating management reports. These costs depend on the number of measures enclosed in the consolidated PMS. In this context, labor costs typically outvalue by far any other reporting costs as the preparation of management reports in general and especially the preparation of special requests is a time-consuming and manual activity. If the consolidated PMS encloses a reduced number of measures, configuration and preparation (e.g., layout, representation, interpretation, and annotations) will require less effort and lower costs. The third cost category covers costs for data collection and quality assurance in the context of ETL procedures. These

costs depend on the composition of the consolidated PMS. For example, the raw data for some measures may be retrieved automatically from an enterprise resource planning system, whereas the raw data for other measures may have to be collected manually. The same holds true for the quality of input data (e.g., timeliness, correctness, completeness). If a measure is dropped from the existing PMS of the business unit under consideration, the respective costs cannot be assigned to the consolidated PMS anymore. The negative economic effects of the consolidated PMS decrease accordingly. Nonetheless, the costs may incur for the company at large if the measure is used by other business units.

Based on these considerations, we propose to formalize the negative economic effects (*NEE*) of a particular consolidated PMS M_{cons} as follows:

$$NEE(M_{\text{cons}}) = \frac{|M_{\text{cons}}|}{|M|} \cdot C_M + \sum_{m_i \in M_{\text{cons}}} c_i \quad (3)$$

where $C_M \in \mathbb{R}^+$ are the costs for configuring, preparing, maintaining, and disseminating management reports based on all existing measures,

$c_i \in \{d_1, d_2, \dots, d_l\}$ is the individual cost level assigned to m_i , and

$0 < d_1 < d_2 < \dots < d_l$, $d_i \in \mathbb{R}^+$ are cost levels.

Equation (3) can be interpreted as follows: The first addend represents the costs that depend on the number of measures enclosed in M_{cons} . Therefore, the fraction of the existing measures that is enclosed in M_{cons} is multiplied by $C_M \in \mathbb{R}^+$. The second addend represents the costs that depend on the composition of M_{cons} . For its calculation, we proceed analogous to the determination of the measure-specific information processing complexity, as it seems reasonable to determine a measure's individual costs approximately and in relation to other measures. We therefore define several cost levels d_i , measured in a fixed currency, assign a specific cost level $c_i \in \{d_1, d_2, \dots, d_l\}$ to each measure $m_i \in M_{\text{cons}}$, and build the sum of the measure-specific cost levels.

4.3. Objective Function

Finally, the mathematical functions that operationalize the objective system of the decision framework have to be integrated into an overall objective function. This function has to reflect the complementary and conflicting relationships among the objectives. A commonly used option is to integrate the mathematical functions into an additive objective function. In the problem setting at hand, the negative informational and economic effects of a consolidated PMS

M_{cons} have to be subtracted from the respective positive informational effects. In line with MCDA, using an additive objective function is allowed if the following assumption holds (Fishburn, 1970; Keeney and Raiffa, 1993):

(A.4) *Objectives (O.1) to (O.4) are mutually preferential independent. Changes in the realizations of one objective can be compensated by the realizations of other objectives.*

Against this backdrop, we propose the following objective function:

$$\begin{aligned}
 & \max_{M_{\text{cons}} \in M} \text{PIE}(M_{\text{cons}}) - \text{NIE}(M_{\text{cons}}) - \text{NEE}(M_{\text{cons}}) \\
 &= \left[\lambda \cdot \frac{|M_{\text{cons}}| + \sum_{m_i \in M \setminus M_{\text{cons}}} R^2(M_{\text{cons}}, m_i)}{|M|} + (1 - \lambda) \right. \\
 & \quad \cdot R^2(M_{\text{cons}}, m_{\text{top}}) \left. \right] \cdot I - \left[\frac{|M_{\text{cons}}|}{|M|} \cdot \frac{\sum_{m_i \in M_{\text{cons}}} e_i}{\sum_{m_i \in M} e_i} \cdot \frac{u_{M_{\text{cons}}}}{u_M} \right] \cdot S \\
 & \quad - \left[\frac{|M_{\text{cons}}|}{|M|} \cdot C_M + \sum_{m_i \in M_{\text{cons}}} c_i \right]
 \end{aligned} \tag{4}$$

We deliberately refrain from using further weighting factors because the importance of each objective is expressed by means of the decision makers' subjective monetary equivalents (i.e., I and S) and the costs for operations and maintenance of the supporting infrastructure. As PMS consolidation is a discrete problem with a finite set of alternatives, the objective function provides a means for valuating and comparing different consolidated PMS. The consolidated PMS for which the objective function reaches the highest value should be selected according to the decision framework. We will discuss in the next section that, due to the inevitable inaccuracies of parameter estimation, the results of the decision framework should be interpreted as recommendations. When applying the decision framework in real-world settings, further sensitivity and scenario analyses should be conducted before starting organizational change projects.

5. Evaluation of the Decision Framework

5.1. Overview

As the evaluation of artifacts is an important phase of design-oriented research, a variety of methods and patterns to perform the evaluation are available (Hevner et al., 2004; Peffers et al., 2008; Vaishnavi and Kuechler, 2008). To evaluate the decision framework for PMS consolidation, we use feature comparison, prototype construction, and a real-world application.

Feature comparison is a method of discursive evaluation in which the characteristics of the artifact are compared with a checklist of requirements that should be met by a useful solution to the problem (Frank, 2006; Siau and Rossi, 1998). Two recent applications that serve as examples are reported in El-Gayar and Fritz as well as Strecker et al. (El-Gayar and Fritz, 2010; Strecker et al., 2011). Prototype construction provides a proof of concept that the features of the proposed artifact can be realized by means of information technology. Feature comparison and prototype construction are suitable for assessing whether an artifact contributes to closing the research gap. It is reasonable to apply these evaluation methods here because the decision framework has not yet been adopted by the industry (Hevner et al., 2004; Strecker et al., 2011). The real-world application complements the other two evaluation steps as it allows for an empirical assessment of whether the decision framework proves useful for subject matter experts who are involved in PMS consolidation.

5.2. Feature Comparison

Regarding feature comparison, the characteristics of the decision framework are compared with the requirements introduced in section 2.2. This is reasonable because, according to the literature, these requirements characterize a useful PMS, and they have been used to identify the research gap. The characteristics of the decision framework are summarized and discussed in Table 3. The discussion also reveals limitations and opportunities for future research, to which we return in section 6. Overall, the decision framework addresses all requirements—particularly those identified as particularly requiring additional research, i.e., (R.3) to (R.5)—in an integrated and quantitative manner. All requirements with a focus on PMS as design products have been integrated into the objective function of the decision framework. The objective function thus covers the informational and economic perspectives of PMS consolidation. The requirements that refer to the process of PMS design are considered in the mathematical operationalization and the quantitative nature of the decision framework.

Requirement	Features of the decision framework for PMS consolidation	Discussion
(R.1) Coverage of the decision makers' information requirements	To determine the extent to which a consolidated PMS covers the decision makers' information requirements, we rely on the stochastic, empirical interdependencies among enclosed and non-enclosed measures (see R.5). On the assumption that all measures are thematically appropriate, each enclosed measure directly contributes to covering the decision makers' information	Relying on stochastic, empirical interdependencies abstracts from the semantics of measures. Therefore, measure-specific meta information (e.g., about whether a particular measure is leading, lagging, financial, or non-financial) and weak aspects, such as the decision makers' subjective information requirements, cannot be considered. One possibility to mitigate this weakness would be to check whether the

Requirement	Features of the decision framework for PMS consolidation	Discussion
	requirements. The interdependencies with the non-enclosed measures at least partially compensate for the missing direct contribution. The idea is that if the variation of a non-enclosed measure can be explained perfectly by the enclosed measures it can be omitted without loss of information.	consolidated PMS is sufficiently balanced after the decision framework has been applied. If not, measures can be added or changed based on careful deliberation. It is important to note that those parts of the decision makers' information requirements that cannot be covered by the existing measures are out of scope. If necessary, novel measures from outside the existing PMS have to be integrated.
(R.2) Alignment with corporate objectives	To determine the extent to which a consolidated PMS aligns with the company's strategy and objectives at a corporate level, we rely on the stochastic, empirical interdependencies between the measures enclosed in the consolidated PMS and the top measure (see R.5). The idea is that if the variation of the top measure can be explained perfectly by the enclosed measures, the consolidated PMS is fully aligned with the company's strategy and objectives at a corporate level.	We assume that the company's strategy and objective at a corporate level are reflected in a single top measure. As large companies sometimes rely on multiple top measures, the decision framework needs to be extended accordingly in future research endeavors.
(R.3) Adequate information processing complexity	To determine the information processing complexity induced by a consolidated PMS, we rely on the number of enclosed measures, the individual complexity of the enclosed measures, and the heterogeneity of the enclosed measures.	The heterogeneity of a consolidated PMS only depends on the different units featured by enclosed measures. Moreover, measure-specific complexity is operationalized using complexity classes instead of detailed estimations.
(R.4) Adequate costs for operations and maintenance of the supporting infrastructure	The costs for operations and maintenance induced by a consolidated PMS are captured by means of two cost classes: overarching costs for configuring, preparing, maintaining, and disseminating management reports, which depend on the number of enclosed measures, and individual costs for data collection and quality assessment.	Determining valid values is a tedious task in real-world scenarios and may cause an inadequate elicitation effort as well as spurious precision. We therefore rely on cost classes instead of detailed estimations.
(R.5) Consideration of interdependencies among measures	The decision framework considers stochastic, empirical interdependencies. The strength of the interdependencies is quantified by means of coefficients of determination as auxiliary quantities calculated via multiple linear regression.	We assume that the interdependencies under investigation are linear in nature and constant over time. To avoid dysfunctional effects, we require that each interdependency can be interpreted and is justified by subject matter experts.
(R.6) Consideration of existing measures	As the decision framework is intended for PMS consolidation, it focuses exclusively on existing measures, i.e., on the question which subset of the existing PMS should be kept or deleted based on	Currently, the decision framework does not consider the effects of novel measures that have not yet been part of the existing PMS. One reason is that no historical data exists for novel measures, so it cannot be

Requirement	Features of the decision framework for PMS consolidation	Discussion
	informational and economic considerations. Moreover, the existing PMS serves as a benchmark for operationalizing (R.1) to (R.4).	determined whether there are any meaningfully interpretable and justifiable interdependencies among existing and novel measures (see R.5). Regarding (R.1), the best result achievable is that the consolidated PMS provides the same information as the existing PMS.
(R.7) Systematic involvement of decision makers and subject matter experts	Decision makers and subject matter experts are involved to justify interdependencies and estimate the values of the input parameters. These input parameters include the monetary equivalents of covering the information provided by the existing PMS and perfect alignment with the objectives at a corporate level (see R.1) as well as for the ability to cope with the information complexity caused by the existing PMS (see R.2). Other input parameters are the mapping of existing measures to complexity classes, which is required for determining the corresponding information processing complexity (see R.3), and cost classes required for determining the cost for operations and maintenance (see R.4).	All these parameters help express the relative importance of the objective function's components. Due to the decision framework's quantitative nature, it can be traced how modifying each parameter influences the outcome of PMS consolidation. It would be a mistake to believe that the decision framework leads to objective and truly optimal decisions in industry. One reason for this is that estimating the parameters' values is beset with subjective influences—we even require the decision makers to indicate subjective values. Another reason is that the stochastic, empirical interdependencies may be subject to data quality problems or lagging effects that have to be separated and eliminated beforehand.

Table 3: Evaluating the Decision Framework for PMS Consolidation Against the Requirements of PMS (Feature Comparison)

5.3. Prototype Construction

In order to provide a proof of concept, the decision framework was implemented using Microsoft Excel and IBM SPSS Statistics 19. The Excel component of the prototype helps organize the input parameters and intermediate results for all components of the decision framework's objective function. It also displays the final results and allows for basic sensitivity and scenario analyses. The functionality of SPSS enables conducting regression analyses and tests of significance.

The input parameters stored in the Excel component include the historical values of the top measure and all measures from the existing PMS as well as measure-specific meta-data such as the measures' names, units, complexity levels, and costs. Further parameters such as the decision makers' subjective monetary equivalents, overarching costs, and the business unit-specific weighting factor belong to the input parameters as well. The intermediate results comprise all bivariate correlation coefficients, the coefficients of determination from the

regression analyses, and the test statistics for each regression analysis. They also include the values for each component of the decision framework's objective function and each different consolidated PMS. The final results show which value the objective function takes for each consolidated PMS, which PMS maximizes the objective function, and what measures this PMS encloses.

The following steps have to be followed when applying the prototype: First, the input parameters have to be fed into the Excel component. The intermediate results for the negative informational effects and the negative economic effects are available immediately after the input parameters have been provided because their calculation does not depend on the results of any statistical analyses. Second, an SPSS routine, which is based on the SPSS application programming interface, needs to be invoked to prepare the calculation of the positive informational effects. This routine determines all possible subsets of the existing PMS, conducts regression analyses for different subsets, calculates coefficients of determination as well as test statistics and stores the output as intermediate results in the Excel component. The Excel component then determines the positive informational effects of all different consolidated PMS. Third, the final results are presented to the user. The user may now conduct basic sensitivity and scenario analyses.

In its current form, the prototype does not provide further assistance in estimating the input parameters' values. It is able to deal with existing PMS of up to ten measures, which we considered sufficient for a proof of concept. Conducting the required regression analyses for a PMS of ten measures takes about 20 minutes, using a regular workstation. In our opinion, this considerable calculation effort is tolerable because PMS consolidation is unlikely to be repeated in very short intervals. Despite the size limitation, the prototype was implemented in such a way that it could easily be adapted to deal with a higher number of measures. For us, the most important insight from prototype construction was that all features of the decision framework for PMS consolidation could be realized by means of information technology.

5.4. Real-world Application

Besides feature comparison and prototype construction, the decision framework and the prototype were applied at the strategic production planning department of an international company in the semiconductor industry. The department is responsible for the supply chain reporting and the PMS of the company's operations department. Two members of the department's management team helped us reflect on the decision framework and collect data for the input parameters. Owing to confidentiality, the identity of the company will not be

disclosed. All data had to be anonymized and slightly modified. However, the principal results still hold. We were not able to cope with the complexity of the entire existing PMS because of the restrictions of the prototype outlined in section 5.3. Nevertheless, we gained valuable insights into the difficulties encountered during data collection and analysis, whether the decision framework creates utility, and which topics might be of interest for future research from the subject matter experts' viewpoint.

As for data collection, we had access to the historical data of ten operations and supply chain performance measures, which represent a subset of the overall PMS used for managing the company's operations department, as well as to the data of a top measure. While the overall PMS covers the production process including the back-end and the front-end stage, our subset focuses on one of these stages. Five measures address the supply chain (SC) performance, two measures the loading and cost performance (LC), and another three measures the yield and quality performance (YQ). Accordingly, we denote the PMS under investigation and the measures it encloses as $M = \{SC_1, \dots, SC_5, LC_1, LC_2, YQ_1, YQ_2, YQ_3\}$. The top measure is a customized form of earnings before interest and taxes. It is reported for each business unit and on a corporate level. As not all measures could be unambiguously assigned to a single business unit, we used the values reported at the corporate level.

When treating the historical data, we faced a couple of challenges: First, owing to numerous carve outs and acquisitions in the company's recent past, the subject matter experts were able to provide only a data set that covers 21 comparable months. From a theoretical point of view, a longer period would have been desirable because the PMS encloses ten measures, which results in up to ten independent variables as input for multiple linear regression. Since we obtained statistically significant results, we proceeded with the restricted data set. Second, while the measures enclosed in the PMS were reported monthly, the top measure was available on a quarterly basis only. Hence, we had to approximate the missing values for the second and third month of each quarter to make all measures comparable. We assumed a linear development from quarter to quarter. Third, the time series of some measures had very few missing values. Analogous to how we treated the top measure, the missing values were estimated by means of a linear approximation on the basis of the values of the preceding and succeeding months respectively. Fourth, we tried to figure out whether there is a lag between the points in time when the values of the measures from the PMS are obtained and when they take effect on the top measure. The experts stated that there certainly is a time lag, which can be predicted fairly well for some measures, but not at all for others. Regarding the case at hand, they argued that the effects cancel out each other. We therefore refrained from more detailed analyses.

Further, we assessed the other input parameters of the decision framework's objective function. We developed a catalogue of questions, which the subject matter experts were asked during a two-hour interview. All input parameters that could not be assessed in the interview, such as labor costs of IT experts or engineers, were estimated by conducting benchmark analyses and Internet research. For the components of the objective function to be comparable, all monetary parameters were calculated on a yearly basis.

Regarding the positive informational effects, the decision makers' subjective monetary equivalent of having all information provided by the existing PMS as well as perfect alignment with the company's objectives at a corporate level was interpreted as the perceived value of the existing PMS. The perceived value was measured by the estimated effort to reconstruct it in a new project, including the necessary systems and procedures for the data collection, data assimilation, and presentation as well as the integration of external data. Such a project was said to take about two years and to require a team of about 25 IT experts and 25 business experts located at the company's headquarters and business units. The total project cost, including the average labor costs for IT and business experts, amounts to 2,400,000 EUR. This corresponds to a subjective monetary equivalent of 1,200,000 EUR per year. As production processes in the semiconductor industry are highly complex and the operations department is critical for the company's overall success, it is important to cover the information provided by the existing PMS. Therefore, the business unit-specific weighting factor was set to 0.8.

The negative informational effects require determining the decision makers' subjective monetary equivalent of coping with the information processing complexity caused by the existing PMS. Relying on the concept of opportunity costs, we examined how often the corresponding management report is discussed, who participates in the management meetings, and how much time these persons spend on preparing for and attending the meetings. The report is prepared once a month and then disseminated to about 40 recipients. It is analyzed by a team of about 25 managers ranging from department heads to the Chief Operating Officer. The report is discussed thoroughly during a six-hour meeting. With average labor costs for different management levels, the subjective monetary equivalent amounts to 200,000 EUR per year. The measures' individual complexity and their units are shown in Table 4.

Regarding the negative economic effects, we assessed the costs for configuring, preparing, maintaining, and disseminating the management reports using all measures of the PMS under consideration. The economic components in particular were difficult to operationalize. We adopted with the following solution: We estimated how much time is necessary to conduct the tasks listed above and to process ad-hoc requests. Since many of these tasks require experienced

professionals, we considered average labor costs for senior engineers. This resulted in yearly costs of 100,000 EUR. Additionally, the experts were asked to indicate the effort associated with data collection and quality assurance for each measure. This was translated into the individual cost levels shown in Table 4. The cost levels are rather high because many of the measures have to be treated manually.

Overarching Parameter	Value	Measure	Complexity* (e_i)	Cost level** (c_i)	Unit (u_i)
Business unit-specific weighting factor (λ)	0.8	SC ₁	4	10,000 EUR	[%]
Monetary equivalent of all information provided by M and perfect alignment with the top measure (I)	1,200,000 EUR	SC ₂	3	10,000 EUR	[%]
Monetary equivalent of coping with information processing complexity (S)	200,000 EUR	SC ₃	3	15,000 EUR	[%]
Overall costs for management reports (C_M)	100,000 EUR	SC ₄	3	15,000 EUR	[Days]
		SC ₅	3	5,000 EUR	[Days]
		LC ₁	5	15,000 EUR	[%]
		LC ₂	2	15,000 EUR	[%]
		YQ ₁	2	15,000 EUR	[%]
		YQ ₂	4	15,000 EUR	[EUR]
		YQ ₃	2	10,000 EUR	[Amount]

* Complexity level: ranging from 1 (simple to understand) to 5 (very complex to comprehend)

**Cost level: 5,000 EUR (mainly automated data collection and preparation), 10,000 EUR (semi-automated) and 15,000 EUR (manual data collection and preparation)

Table 4: Input Parameters

After data collection, we calculated the value of the objective function for each subset of the existing PMS through the prototype. The consolidated PMS M_{cons}^* for which the objective function reaches the highest value contains six measures: SC₂, SC₃, SC₅, LC₁, YQ₁, and YQ₃. This corresponds to a reduction of 40% in the number of measures. Moreover, the information complexity and the costs for operating and maintaining the supporting infrastructure could be reduced by 75% and 40% respectively. The enclosed measures on average explain 97% of the variance of each measure from the existing PMS and 90% of the top measure's variance. Moreover, the optimal consolidated PMS still covers all performance dimensions relevant to the subject matter experts.

For a deeper understanding of the final results, we analyzed the intermediate results provided by the prototype. It can be seen that the values of the objective function for the different consolidated PMS are very close, which might at first sight be seen as indicative of non-robust

results. A closer look, however, reveals the optimal consolidated PMS is robust with respect to size and content. The top 25 consolidated PMS in terms of the objective function, encompass either five (eight times) or six measures (17 times). The best consolidated PMS enclosing seven measures is ranked 26th, and the best consolidated PMS with four measures is ranked 91st. The value of the objective function achieved by the best consolidated PMS with seven and four measures differs by 4% and 7%, respectively, from the value achieved by the optimal consolidated PMS. This is considerable if one takes into account that, on average, two consecutive consolidated PMS from the top 25 differ by about 0.1% only. In addition, three measures from the optimal consolidated PMS (i.e., SC_3, SC_5, YQ_3) are enclosed in more than 20 of the top 25 consolidated PMS, while the other three measures (i.e., SC_2, LC_1, YQ_1) are part of more than 10 of the top 25 consolidated PMS. This is corroborated by an analysis of the bivariate correlation coefficients. The measures SC_3 and SC_5 , for example, interdepend strongly with different non-enclosed measures and thus create highly positive informational effects. The measure YQ_3 , in contrast, interdepends with almost no other measure, so its absence cannot be compensated for by any enclosed measure. In addition, the measures SC_3, SC_5 , and YQ_3 do not interdepend with one another.

Overall, the decision framework created utility for the subject matter experts as it provided them with recommendations and means for further analysis. It also helped systematize the consolidation processes. Thus, the subject matter experts could triangulate their gut feeling about important measures as well as the understanding they believed to be correct about the relationships governing the business unit with the proposals made by the decision framework.

Besides the application of the decision framework, the discussions with the subject matter experts revealed further topics related to PMS consolidation that, from their viewpoint, might be of interest for future research. Besides the challenge of ensuring high data quality in a complex and globally distributed organization, one of the experts' main challenges arise in adapting their performance measurement activities to changing information requirements of the management. In economic downturns, for example, the company's supply chain reporting focuses much more on cashflow-related measures, whereas strong emphasis is laid on quality- and efficiency-related measures in economic upturns. Consequently, in research on PMS consolidation, it may be necessary to take some measures out of the PMS temporarily when they are not the focus of reporting. During this period, these measures entail neither positive nor negative informational effects; rather, they entail negative economic effects as data collection and quality assurance have to be continual in order for the measures to be reintegrated into the reporting quickly and with up-to-date values. Moreover, research is needed to

determine which PMS should be consolidated with respect to which top measure, how potential hierarchic relationships between PMS can be addressed, and how interdependencies among top measures and the measures enclosed in different PMS should be treated. The last topic mentioned relates to the fact that currently only the final results of applying the decision framework are used to adapt the content of reports. Performance measurement research should investigate how input parameters (e.g., measure-specific levels of information processing complexity; costs for data collection and for quality assurance) as well as intermediate results (e.g., the strengths of the interdependencies among the existing measures; the results from multiple regression analysis) can be leveraged to improve the decision makers' overall understanding of the unit of analysis and a company's performance measurement activities in entirety.

In summary, the results of all the applied evaluation methods confirm that the decision framework makes an incremental contribution to meeting the requirements for useful solutions to the problem of PMS consolidation. Moreover, the decision framework can be implemented by means of information technology and appears to be useful in assisting subject matter experts from the industry in carrying out the consolidation of existing PMS.

6. Conclusion and Outlook

In this paper, we addressed the question of how existing PMS can be consolidated in line with the informational and economic challenges of information provision. PMS are interpreted as conceptual artifacts that enclose multiple interdependent measures and rely on a supporting infrastructure comprising information systems and procedures of information provision. To answer the research question, we followed a design science research approach and drew from the MCDA knowledge base. Our artifact is a decision framework for PMS consolidation. The construction of this framework was guided by PMS-related requirements extracted from the management accounting, operations management, and performance measurement literature. The requirements address the informational and economic perspectives of PMS consolidation, considering PMS as design products and the process of PMS design. In line with these requirements, the objective function of the decision framework includes components that refer to the coverage of the decision makers' information requirements, the alignment with corporate objectives, adequate information processing complexity, and adequate costs for operations and maintenance of the supporting infrastructure. Each component is operationalized by means of a mathematical function such that both the measures of existing PMS and the interdependencies

among these measures are considered. Moreover, decision makers and subject matter experts are involved systematically.

The decision framework provides assistance in consolidating existing PMS against the background of partially conflicting informational and economic objectives. Thereby, the information processing complexity and the costs for operating and maintaining the supporting infrastructure can be reduced in a manner that is reasonably balanced with the extent to which a consolidated PMS covers the information requirements and aligns with the company's objectives at a corporate level. Due to the fact that many parts of the PMS consolidation process can be automated—as demonstrated by the prototype—manual effort can be reduced as well. Contrasted with existing approaches and based on the evaluation results, the decision framework is an integrated and quantitative approach that makes an incremental contribution to solving the problem of PMS consolidation.

Both the decision framework and its applicability are beset with limitations that motivate future research in the field of PMS consolidation. Some limitations have already been discussed in section 5.

1. Some assumptions of the decision framework are simplifying. For example, we assume that the company's objectives are captured by means of a single top measure, that the interdependencies among measures are linear and constant, or that the heterogeneity of the measures enclosed in a PMS can be quantified by means of the number of different units. It has to be challenged in future research which of these assumptions can and should be relaxed. One has to keep in mind that the decision framework is a model of the real world conceived by purposeful abstraction that does not intend to capture all the complexity of the real world. Thus, it is imperative to deliberate carefully whether the increase in closeness to reality gained by relaxing certain assumptions outvalues the increase in the decision framework's complexity and the additional effort of eliciting values for the input parameters.
2. So far, the scope of the decision framework is limited to a single business unit. Multiple business units can only be addressed successively and in isolation. Moreover, the case that measures are thematically appropriate for multiple business units is neglected. Taking on a single business unit perspective also constrains the alignment with corporate objectives because we can only use the “fractional” contribution of the business unit under investigation. The fractional contribution of other business units and

potential diversification effects are ignored. An integrated investigation of multiple business units would be desirable and of importance for practice and research.

3. As for almost all formal models, the main difficulty of applying the decision framework in practice is determining valid values for the input parameters. The mathematical operationalization proposed for the components of the decision framework's objective function intend to mitigate this difficulty, for example, by relying on cost and complexity levels instead of detailed assessments. We provide additional guidance, for example on how to determine values for decision makers' subjective monetary equivalents, as well as lessons learned from applying the decision framework in a real-world setting. Nevertheless, the practical applicability would benefit from identifying and assessing other ways for operationalizing the decision framework's input parameters. One should involve multiple case studies and extensive discussions with subject matter experts from industry.
4. The decision framework was evaluated by means of feature comparison, prototype construction, and a real-world application. In line with the recommendations for an enhanced practical applicability, further evaluation steps should be conducted to assess how the artifact can be applied in real-world settings, creates utility, and outperforms competing artifacts. This, however, needs to be done in future research endeavors because the context and data currently available from reports on the application of existing approaches to PMS consolidation are not rich enough to enable a comparison with the decision framework. In the course of further evaluation, the prototype that is currently based on Microsoft Excel and IBM SPSS Statistics 19 should be improved as well, for example, with respect to interfaces to data sources, a more convenient user interface, and support for eliciting values for the decision framework's input parameters.

Despite these potentials for improvement, the decision framework enriches the body of knowledge related. We hope that it helps fellow researchers with their work on PMS consolidation.

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III. Performance Measures Relating to Digitalization

Research Paper 2: “Who will lead and who will follow: Identifying Influential Users in Online Social Networks - A Critical Review and Future Research Directions”

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Abstract: Along with the explosive growth of the phenomenon Online Social Networks (OSN), identifying influential users in OSN received a great deal of attention in recent years. However, the development of practical approaches for the identification of influential users is still in its infancy and researchers face numerous challenges. By means of a structured literature review, we analyze and synthesize the growing number of publications particularly from two perspectives. From a research perspective, we find that existing approaches mostly build on users' connectivity and activity but hardly consider further characteristics of influential users. Moreover, we outline two major research streams. It becomes apparent that most marketing-oriented articles draw on real-world datasets of OSN, while rather technical-oriented papers have a more theoretical approach and mostly evaluate their artifacts by formal proofs. We find that an even stronger collaboration between the scientific Business & Information Systems Engineering (BISE) and Marketing community than observed today could be mutually beneficial. With respect to a practitioner's perspective, we compile advice on the practical application of approaches for the identification of influential users. It is hoped that the results can stimulate and guide future research.

1. Introduction

For decades, marketers have been intensively investigating the effects driving the diffusion and adoption of new products and services. In this context, major developments could be observed over the last couple of years: First, the impact of traditional marketing techniques has been constantly decreasing (Clemons, 2009, p. 48 f.; Hinz et al., 2011, p. 55; Trusov et al., 2009, p. 90). Second, consumers increasingly trust in recommendations of other consumers, acquaintances, and friends (Chen and Xie, 2008; Iyengar et al., 2011b; Narayan et al., 2011; Schmitt et al., 2011). Third, it recently has become widely accepted that social influence actually affects the diffusion process and that there are influential people who have disproportionate influence on others (Godes and Mayzlin, 2009; Goldenberg et al., 2009; Hinz et al., 2013; Iyengar et al., 2011a). Such social influence can be defined as “[...] change in the belief, attitude, or behavior of a person [...], which results from the action, or presence, of another person [...]” (Erchul and Raven, 1997, p. 138), usually denoted as influencer. To respond to these developments and to leverage the effect of social influence on product adoption, companies increasingly try to actively initiate and control the diffusion process by targeting the most influential people in a social network (Bonchi et al., 2011, p. 21; Hinz et al., 2011, p. 55; Libai et al., 2010, p. 271). Thus, with small marketing costs a very large part of the network should be reached. However, among others, one key prerequisite needs to be fulfilled: Companies need to be able to identify and target the “right” initial set of influential people (Iyengar et al., 2011b, p. 195; Hinz et al., 2011, p. 55 f.).

Traditionally, self-designation, that is, people report their own influence in surveys (cf. Rogers and Cartano, 1962), has been popular to identify influential people. More sophisticated sociometric techniques, that is, using network data on social connections, could only scarcely be used at a larger scale, as datasets have often been too small (Corey, 1971, p. 52; Watts, 2004, p. 5). However, due to the rise of modern communication networks and the Internet, the usage of network data for the identification of influential people gained increasing popularity in research and practice (cf. e.g., Bampo et al., 2008; Hill et al., 2006; Hinz et al., 2011; Nitzan and Libai, 2011). Especially along with the explosive growth of the phenomenon of Online Social Networks (OSN) to currently more than one billion active users and 140 billion friendship connections as of October 2012 solely on Facebook (Facebook, 2012), identifying influential users in OSN is receiving a great deal of attention in recent years (Bonchi et al., 2011, p. 21; Hinz et al., 2013; Katona et al., 2011, p. 426). Besides mere social connections, which for instance could be observed in telecommunication networks as well, OSN allow for analyzing the diffusion process taking into account additional information such as detailed

demographic data, personal interests, the level of activity with respect to different technical features of OSN (e.g., comments, likes), and partly even the content and sentiment of communication (e.g., in public wallposts). Moreover, users thereby usually reveal more information than in an offline context, as online communications tend to be more uninhibited, creative, and blunt (Wellman et al., 1996, p. 213). Thus, OSN provide a unique and vast amount of user data (also referred to as “digital trace data”, cf. Howison et al., 2011) that was not available before and can now be leveraged for marketing purposes¹ (Bonchi et al., 2011, p. 2; Katona et al., 2011, p. 425 f.; Subramani and Rajagopalan, 2003, p. 301).

However, the development of practical approaches for the identification of influential users in OSN is still in its infancy (Richter et al., 2011, p. 98) and researchers face numerous challenges: First, the processing of previously unknown large amounts of (digital trace) data and the consequently required scalability of existing approaches for the identification of influential people are not trivial (cf. e.g., Watts, 2004). Second, research based on such data faces numerous validity issues (cf. Howison et al., 2011) and several sources of bias might confound the identification of influential users in OSN (cf. section 2.1). Third, findings from research on viral marketing and the identification of influential people in an offline environment or from the “old Internet” may not be transferred to the context of OSN without critical reflection (cf. e.g., Brown et al., 2007; Eccleston and Griseri, 2008, p. 608; Howison et al., 2011, p. 768; Susarla et al., 2012). Therefore, further research is needed in order to overcome these challenges and to achieve a better understanding in research and practice.

What can a critical literature review contribute? We believe that the growing number of publications on the identification of influential users in OSN needs to be analyzed and synthesized to assess the applied methods, knowledge, and theories (Scandura and Williams, 2000) as well as to identify research gaps that can be addressed in future research (Webster and Watson, 2002). For our following analysis, we define OSN as “[...] web-based services that allow individuals to (1) construct a public or semi-public profile within a bounded system, (2) articulate a list of other users with whom they share a connection, and (3) view and traverse their list of connections and those made by others within the system” (Boyd and Ellison, 2007, p. 211) but focus on user-oriented sites (Pallis et al., 2011, p. 220), “[...] where, to a certain extent, networking is the main preoccupation” (Beer, 2008, p. 518). In contrast, content-oriented sites such as Twitter, YouTube, or Flickr exhibit some features of OSN but are rather

¹ For a critical discussion of related fundamental problems such as the access to data from OSN, privacy issues, and validity concerns see for instance Howison et al. (2011), Lazer et al. (2009) and with respect to the identification of influential users in OSN section 5.

microblogging sites or content communities with different characteristics than OSN (Heidemann et al., 2012, p. 3867; Pallis et al., 2011, p. 220; Richter et al., 2011, p. 90; Smith et al., 2012, p. 103). For instance, Wu et al. (2011, p. 707) found that Twitter “[...] does not conform to the usual characteristics of social networks, which exhibit much higher reciprocity [...] [Kossinets and Watts, 2006]”. Prior research also emphasizes that on content-oriented sites “[...] the primary motivation and goal of the majority of users is the content instead of socialization” (Laine et al., 2011, p. 2). Some content-oriented sites are therefore even perceived as a “[...] mixture of one-way mass communications and reciprocated interpersonal communications” (Wu et al., 2011, p. 707). Consequently, (partly) different data can be collected in OSN and content-oriented sites (e.g., friendship connections in Facebook versus followers in Twitter). Treating them interchangeably might raise several validity issues along the chain of reasoning when drawing conclusions on a construct under consideration (e.g., social influence) based on data from these information systems (i.e., a content-oriented site or an OSN) (cf. Howison et al., 2011, p. 772). For instance, theoretical cohesion might not be given when operationalizing constructs deduced from theories on (offline) *social networks* with data from content-oriented sites. Before in further research the focus could be on the identification of influential users in content-oriented sites and commonalities and differences to their identification in OSN, this paper aims at laying the foundations by concentrating on OSN as the currently predominant phenomenon. Thereby, two particular perspectives should be informed (cf. Poeppelbuss et al., 2011, p. 506): a research perspective that relates to the theoretical and methodological aspects and a practitioner’s perspective that covers issues relevant to users of approaches for the identification of influential users in OSN.

The remainder of this paper is organized as follows: In the next section, we provide an overview on important foundations from the context of social influence as well as the identification of influential people in social networks and delineate three research questions: (1) How are influential users characterized in the context of OSN? (2) Which approaches have been developed and applied for the identification of influential users in OSN? (3) How have these approaches been evaluated and which implications have been derived? In section 3, we outline the procedure of our structured literature search. In the subsequent section 4, we present our findings regarding the three research questions and critically discuss the identified articles from a research perspective. By highlighting nine implications of our literature review, we point out future research directions in section 5. Thereby, also an audience from practice, who adopt approaches for the identification of influential users, can benefit. Finally, in section 6 we draw an overall conclusion and explicate limitations.

2. Foundations and Research Questions

As previously mentioned, marketers aim at targeting the most influential people in social networks in order to initiate a diffusion process that allows for reaching a large part of a network with small marketing cost (Bonchi et al., 2011, p. 21). To do so, three key assumptions need to be fulfilled (Iyengar et al., 2011b, p. 195): (1) social influence needs to be at work, (2) there actually need to be influential people in the social network who have disproportionate influence on others, and (3) companies need to be able to identify and target these influential people. With respect to these three assumptions, we briefly review relevant literature from economics, marketing, and sociology beyond the context of OSN that constitutes the foundation for research on the identification of influential users in OSN. Thereby, we also derive our research questions that are addressed in the subsequent structured literature review.

2.1. Social Influence in the diffusion process

After Moreno (1934) coined the term “sociometry” when formalizing social relationships, Rapoport (cf. e.g., Rapoport, 1952; 1953; Rapoport and Rebhun, 1952) was one of the first who applied “[...] sociometric ideas to large-scale social systems [...]” and “[...] elaborated on the formal implications [...]” in the context of predictive epidemiological models of contagion (Scott, 2000, p. 15 f.). Similar ideas have been used to understand the diffusion of innovations (cf. e.g., Rogers, 1962), such as technical innovations in an agricultural context (Beal and Bohlen, 1955; 1957; Ryan and Gross, 1943), or new drugs in physicians’ networks (Coleman et al., 1966). While these studies implied that diffusion was driven by communication (cf. also Valente, 1995; Valente and Rogers, 1995), others found contradicting results showing that diffusion was rather a result of imitation (Mansfield, 1961) or comparison (Burt, 1987). Strang and Tuma (1993) even found traces for both, communication and comparison effects. In the field of marketing, Arndt (1967) studied product-related word-of-mouth with respect to the diffusion of information, which led to ground-breaking product growth models (cf. e.g., Bass, 1969; Mahajan and Muller, 1979). Hereby, diffusion has traditionally been perceived again only as theory of interpersonal communication (Peres et al., 2010, p. 92). Besides this interpersonal communication, some more recent studies suggest incorporating additional potential sources of influence on the diffusion process (e.g., Goldenberg et al., 2010; Van den Bulte and Lilien, 2001). Peres et al. (2010, p. 92) consequently state that influence should “[...] include all of the interdependencies among consumers that affect various market players with or without their explicit knowledge”. In this context, it generally needs to be distinguished

between social influence and heterogeneity as driving forces of diffusion (Peres et al., 2010, p. 92 f.; Van den Bulte and Stremersch, 2004).

In line with French and Raven (1959), who developed one of the most recognized frameworks in the area of social and interpersonal power (Mintzberg, 1983), social influence can be defined as “[...] change in the belief, attitude, or behavior of a person [...], which results from the action, or presence, of another person [...]” (Erchul and Raven, 1997, p. 138). Such social influence can be induced by all kinds of consumer interactions like traditional one-to-one word-of-mouth, the observation of others, or one-to-many communication as in the case of OSN (Godes et al., 2005, p. 416; Nitzan and Libai, 2011, p. 25). In literature, the process of social influence is also often referred to as social contagion (e.g., Hinz et al., 2013; Iyengar et al., 2011b; Van den Bulte and Stremersch, 2004). Van den Bulte and Wuyts (2007) distinguish five reasons for social contagion (cf. also Van den Bulte and Lilien, 2001), with the first two being especially relevant for viral marketing (Hinz et al., 2011, p. 59). First, awareness and interest for a product or innovation might be induced by information transferred for instance by word-of-mouth (cf. e.g., Katz and Lazarsfeld, 1955). Second, social learning about benefits, costs, and risks of products, services, or innovations might allow reducing search efforts and uncertainty (cf. e.g., Iyengar et al., 2011a). Third, normative pressures might lead to discomfort when not adopting a new product or innovation, that is, people feel the need to conform to the expectations of their peer group as they wish to fit in (cf. e.g., Asch, 1951; Deutsch and Gerard, 1955). Fourth, not adopting a product or innovation might even lead to status or competitive disadvantages. In literature, the first three reasons are also referred to as cohesion and the fourth as structural equivalence (Burt, 1987). In this context, a recent study by Hinz et al. (2013) indicate that structural equivalence drives adoption more than cohesion. Fifth, network externalities might drive social contagion due to an increasing utility that originates from the consumption of a good when the number of other people consuming this good grows (cf. e.g., Granovetter, 1978; Katz and Shapiro, 1994).

In contrast, research under the heterogeneity hypotheses claims that diffusion rather depends on heterogeneous consumer characteristics such as innovativeness, price sensitivity, or needs that influence the probability and time of adoption (Peres et al., 2010, p. 92). Since common diffusion models (e.g., Bass, 1969) often assume a fully connected and homogenous social network or omit marketing efforts (e.g., Coleman et al., 1966), doubts have been rising whether social influence has been overestimated (Van den Bulte and Lilien, 2001; Van den Bulte and Stremersch, 2004). Further studies show that the role of social influence may also have been confounded due to several potential sources of bias (cf. e.g., Aral and Walker, 2012; Garg et

al., 2011; Hartmann et al., 2008), such as simultaneity (i.e., the tendency for connected users to be exposed to the same external stimuli) (Godes and Mayzlin, 2004), homophily and endogenous group formation (i.e., the tendency to choose friends and to form social groups with similar tastes and preferences) (Aral et al., 2009; Hartmann, 2008; McPherson et al., 2001; Nair et al., 2010), or other contextual and correlated effects (Manski, 1993; Manski, 2000; Moffitt, 2001). Therefore, recent studies have been controlling for heterogeneity and other potential sources of bias (cf. e.g., Garg et al., 2011; Hinz et al., 2013; Nair et al., 2010; Susarla et al., 2012), for instance by conducting large-scale randomized experiments in real-world settings (cf. e.g., Aral and Walker, 2012). Other studies have been decomposing the adoption process in its different phases (e.g., awareness and evaluation phase, adoption phase) while incorporating marketing efforts (Manchanda et al., 2008; Van den Bulte and Lilien, 2003). Taken together, even though also heterogeneity and several other factors play an important role in the diffusion process, the presence of social influence could be confirmed and is generally acknowledged today (Iyengar et al., 2011a).

2.2. Characterization of Influential People in Social Networks

Already since Katz and Lazarsfeld (1955) started the discussion about the “flow of mass communications”, it is agreed upon the fact that some people are more influential than others (cf. e.g., Godes and Mayzlin, 2009; Goldenberg et al. 2009; Iyengar et al., 2011a). Their original definition of influential people as “[...] individuals who were likely to influence other persons in their immediate environment” (Katz and Lazarsfeld, 1955, p. 3) with respect to their opinions and decisions remained more or less unchanged until today (Watts and Dodds, 2007, p. 442). A central question in this context is how these influential people can be characterized. Katz (1957) states that the ability to influence is related to three (personal and social) factors (cf. Weimann, 1991, p. 2): (1) the personification of certain values (“who one is”), (2) the competence (“what one knows”), and (3) the strategic social location (“whom one knows”). This categorization finds also affirmation in the works of Gladwell (2000) and Watts and Dodds (2007). The first factor alludes to distinct characteristics, that is, abilities which make a person persuasive. For instance, usually salesmen have these charismatic traits and communication abilities to successfully convince people (Gladwell 2000, p. 70; Eccleston and Griseri, 2008, p. 595). Watts and Dodds (2007, p. 442) characterize such people to be respected by others. The second factor relates to mavens, that is, highly informed individuals (Watts and Dodds, 2007, p. 442) or even experts in distinct fields of knowledge (Gladwell 2000; Eccleston and Griseri, 2008). Mavens might be especially influential in the case of cohesion driven by information transfer and social learning (cf. e.g., Iyengar et al., 2011a), whereby it is important

to bear in mind that peoples' influence might be contextual sensitive. The last factor describes the position of an individual within a society. It specifically refers to connectors, characterized as "[...] people with a special gift for bringing the world together" (Gladwell, 2000, p. 38). Such people are usually well-connected (Watts and Dodds, 2007, p. 442) and enjoy meeting new people as well as introducing them to others they know (Eccleston and Griseri, 2008, p. 594). Thus, people with a high degree of connectedness have the opportunity to influence the behavior of others (Barabási, 2003; Van den Bulte and Wuyts, 2007). Van den Bulte and Stremersch (2004) point out that such well-connected people might be particularly influential when cohesion (cf. section 2.1.) is at work. In case of competition for status, however, this might not be the case (Burt, 1987). Furthermore, tie strength, that is, the intensity of the connections, moderate the impact of social influence (cf. e.g., Brown and Reingen, 1987; Burt, 1992; Granovetter, 1973).

By means of these three – not mutually exclusive – factors, Katz (1957) provided a classification scheme of how influential people can be characterized in general. With the provided context at hand, we first examine how influential people are characterized in literature on the identification of influential users in OSN:

Q.1 How are influential users characterized in the context of OSN?

2.3. Identification of Influential People in Social Networks

Multiple studies investigating the question whether and to what extent people might be influential focused primarily on the strategic location within a social network based on its structural characteristics (cf. e.g., Borgatti, 2006, p. 21; Bampo et al., 2008; Kiss and Bichler, 2008) (cf. third factor that characterizes influential people, section 2.2). Structural characteristics are thereby defined as patterns of connections among actors in a social network (cf. Oinas-Kukkonen et al., 2010). The structure resulting from connections among people is mostly described as a set of nodes and directed or undirected edges that connect pairs of nodes. These nodes and edges determining the network structure can be represented by a graph (Watts, 2004; Wasserman and Faust, 1994).

Several approaches for the identification of important nodes in such a graph can be found in social network analysis (SNA) (for an overview of SNA in the context of marketing cf. e.g., Iacobucci, 1996). For instance, several measures exist that indicate the social influence of nodes on other nodes in a network (Friedkin, 1991). The three most common measures to quantify the centrality of a certain node in social networks are presented in Freeman's article "Centrality in Social Networks: Conceptual Clarification" (Freeman, 1979): Degree centrality, closeness

centrality, and betweenness centrality (for a critical review with respect to a marketing context cf. e.g., Kiss and Bichler, 2008; Landherr et al., 2010). The first centrality measure called degree centrality represents the simplest instantiation of centrality, assuming that a node with many direct connections to other nodes is central to the network. Such well-connected nodes are often called “hubs” (Bampo et al., 2008). As Hinz et al. (2011, p. 57 ff.) point out, some studies suggest that these hubs should be considered as influential people (cf. e.g., Iyengar et al., 2011b; Kiss and Bichler, 2008; Van den Bulte and Joshi, 2007). However, other studies found that “fringes”, that is, poorly connected nodes characterized by low degree centrality might be particularly influential (cf. e.g., Galeotti and Goyal, 2009; Sundararajan, 2006). The second measure named closeness centrality expands the definition of degree centrality by focusing on how close a node is to all other nodes in the network. The idea behind the third measure referred to as betweenness centrality is that if a node is more often on the shortest paths between other nodes, it is more central to the network. Prior work also indicates that such “bridges” connecting otherwise unconnected parts of a network should be considered as influential people (cf. e.g., Rayport, 1996; Hinz and Spann, 2008). A further popular centrality measure, namely eigenvector centrality, is proposed by Bonacich (1972). Since a node’s connectivity in the whole network is incorporated (Bolland, 1988), approaches based on the eigenvector try to find well-connected nodes in terms of the global or overall structure of the network, and pay less attention to local patterns (Hanneman and Riddle, 2005). Connections to nodes that are themselves influential are therefore assumed to lend a node more influence than connections to less influential nodes (Newman, 2003). Thus, eigenvector centrality and related measures such as PageRank deviate from degree, closeness, and betweenness centrality by modeling inherited or transferred status (Liu et al., 2005) that also allows for modeling network effects in the context of viral marketing (cf. e.g., Richardson and Domingos, 2002). Taken together, it can be stated that despite the extensive usage of these well-established centrality measures, “[...] little consensus exists regarding recommendations for optimal seeding strategies” (Hinz et al., 2011, p. 58).

The second research stream on the identification of influential people goes back to Domingos and Richardson (2001), who studied the so-called “*influence maximization problem*”. This refers to the combinatorial optimization problem of identifying the target set of influential people (also often referred to as “top-*k* nodes”) that allows for maximizing the information cascade in the context of viral marketing (cf. also Richardson and Domingos, 2002). By applying three approximation algorithms to their NP-hard problem, Domingos and Richardson (2001) were able to prove that the selection of the “right” target set can make a substantial

difference for a marketing campaign. Based on these works, Kempe et al. (2003) investigated two of the “[...] most basic and widely-studied diffusion models” (Kempe et al., 2003, p. 138), that is, the linear threshold (LN) and the independent cascade (IC) model. Both models are so-called susceptible/infectious/recovered (SIR) models that do not allow for multiple activations of the same node: The IC model is usually considered as a push model, since nodes (information sender) independently try to propagate information to connected nodes in the network. In contrast, the LN model can be considered as a pull model, where nodes (information receiver) accept information if many connected nodes have already accepted. In this case, acceptance of propagated information is determined by a random threshold. Even though Kempe et al. (2003, p. 138) found that also under the IC and LN model it is NP-hard to determine the target set of influential people, they were able to derive the first approximation guarantee for the proposed greedy algorithm by arguing that their objective function is monotone and submodular (for a more general model and further approximation algorithms cf. e.g., Chen et al., 2009; Leskovec et al., 2007). Moreover, the proposed approximation algorithm significantly outperformed heuristics based on centrality measures (Kempe et al., 2003). Even-Dar and Shapira (2011) apply another approach to solve the influence maximization problem, namely the so-called voter model. While the IC and LN model consider only the status of the network in the case of convergence to the steady state (Bonchi et al., 2011, p. 24), the voter model can be applied with different target times. Furthermore, it also overcomes a major limitation of the approach by Kempe et al. (2003), that is, the assumption that only one player introduces a product in the market. Besides Even-Dar and Shapira (2011), also Bharathi et al. (2007) and Carnes et al. (2007) suggested approaches for solving the influence maximization problem in a competitive environment.

Taken together, the first major research stream on the identification of influential people in social networks focuses on the strategic location while the second solves the influence maximization problem by applying diffusion models and (greedy) algorithms. However, as outlined within the introduction, these findings may not be transferred to OSN without further reflection. Therefore, we investigate which of the above mentioned and which further approaches are applied in the context of OSN in order to identify influential users. Furthermore, the specific evaluation of these approaches and implications for theory and practice shall be outlined. Hence, we address two further questions in the following:

Q.2 Which approaches have been developed and applied for the identification of influential users in OSN?

Q.3 How have these approaches been evaluated and which implications can be derived for theory and practice?

3. Literature Search

A systematic, comprehensive as well as replicable literature search strategy is regarded essential for a profound literature analysis on a certain topic of interest (vom Brocke et al., 2009). Bandara et al. (2011, p. 4) delineate two important cornerstones for the literature review process: First, one has to define which *sources* shall be searched (Webster and Watson 2002). Second, the precise *search strategy* needs to be defined, that is, relevant search terms, search fields, and an appropriate period of time (Cooper, 1998; Levy and Ellis, 2006). Finally, we outline the (number of) included and excluded articles and the selection procedure to allow for comprehensibility (vom Brocke et al., 2009).

3.1. Sources

In order to identify relevant publication organs, some authors suggest focusing on leading journals of the research discipline under investigation (Webster and Watson, 2002, p. 16). However, as this restricts the search results beforehand, this approach should only be applied if the topic of interest can be narrowed down to specific journals. Elsewise, a broad database search is advised (Bandara et al., 2011, p. 4). As research on OSN is quite broad and wide-spread over diverse disciplines such as Management Science, Marketing, IS, or Computer Science, we conducted an extensive query in quality scholarly literature databases (cf. Table 1) (Levy and Ellis, 2006, p. 189; vom Brocke et al., 2009, p. 8). We purposely accept duplicates instead of being limited to journals or conferences provided by a certain vendor (Levy and Ellis, 2006, p. 189).

3.2. Search Strategy

For querying the scholarly databases, we derived the following search terms from literature, and applied them by string concatenations. As several synonyms for the terminology OSN can be found in literature, we searched for “*social network*” as an umbrella term to cover different term variations, such as Online Social Network or Social Network(ing) Site (cf. Richter et al., 2011). Additionally, we applied the search terms “*influential*” (covering also influential user), “*influencer*”, “*key user*”, “*hub*”, and “*opinion leader*” (cf. Goldenberg et al., 2009, p. 1; Libai et al., 2010, p. 271). We searched the databases with these terms per title, abstract and keywords. As the first recognizable OSN SixDegrees launched in 1997 (Boyd and Ellison, 2007), we chose

a six-teen year period for our search spanning from 1997 to 2012. Table 1 summarizes the search strategy.

Databases	AIS eLibrary, EBSCOhost, EmeraldInsight, IEEEExplore, INFORMS, ProQuest, ScienceDirect, SpringerLink, Wiley InterScience
Search Terms	(“social network”) AND (“influential” OR “influencer” OR “key user” OR “hub” OR “opinion leader”)
Search Fields	Title, Abstract, Keywords
Time Period	1997 – 2012

Table 1: Summary of the Search Strategy

3.3. Search Results

In order to determine the relevant articles with respect to our research questions (cf. section 2), at least two authors have screened all search results. Only such articles have been selected, that in essence provide a clear proposition on how influential users can be identified. Thereby, also at least one of the following criteria had to be fulfilled: (1) The article explicitly focuses on OSN, either as defined within the introduction or on OSN in general without further definition. (2) The article explicitly states that the derived results are applicable for OSN or the applicability is actually demonstrated by means of using an OSN data set.

The initial database query resulted in 1,912 articles. In a first step, we analyzed each article regarding its title, abstract, and publication organ in order to exclude all articles which obviously did not match our research focus. This reduced the set of articles to 180. In a second step, we examined these articles by a full-text review to verify whether an article corresponds to our research question and to assess the quality of the article’s publication organ. Thereby, we excluded articles that were obviously not subject to some kind of formalized peer-review or quality verification (Levy and Ellis, 2006, p. 185). Besides journals, also conferences² were considered (Webster and Watson, 2002, p. 16) as they offer valuable contributions in the exchange of ideas and promote the development of new research agendas (Levy and Ellis, 2006, p. 185). Articles that were too short for a thorough content analysis (e.g., contributions for a poster session) (Poeppelbuss et al., 2011, p. 509), and professional magazines, newspapers, or patents were excluded (Levy and Ellis 2006, p. 185). As the field of research on OSN is quite

² If workshop or conference papers were identified that have been published also in a journal, only the journal article has been considered when in essence the key findings remained the same.

young (Richter et al., 2011, p. 89), we also excluded books, as methods and theories need some time to be established and verified before being generally accepted. By this means, we obtained 12 mere approaches for the identification of influential users in OSN. By backward search, that is, by studying each article's references (Levy and Ellis, 2006, p. 191), we located another four relevant articles. In summary, a set of 16 articles serves as the basis for our subsequent content analysis.

4. Findings and Critical Discussion

In the following, we analyze the relevant articles with respect to the delineated research questions. As all these articles deal with the identification of influential *people* in the context of OSN, we hereafter refer to them as influential *users*.

Q.1 How are influential users characterized in the context of OSN?

The broadly accepted fact that some people are more influential than others (Katz and Lazarsfeld, 1955) seems to hold true also for OSN (Libai et al., 2010). As outlined in section 2.2, Katz (1957) observed in an offline context that personal influence is related to three (personal and social) factors, namely: “who one is”, “what one knows”, and “whom one knows” (Katz 1957, p. 73). These categories have been confirmed to be also applicable for a Web 2.0 context by Eccleston and Griseri (2008). To determine the influence of users in OSN, Eirinaki et al. (2012) deduced two properties, namely popularity and activity, together with several parameters for their measurement in OSN. Looking closely at the parameters of popularity suggested by Eirinaki et al. (2012), the factors “who one is” and “whom one knows” by Katz (1957) can be found to be covered. However, the original three (personal and social) factors need to be complemented by users' activity for the analysis of influence in the context of OSN: First, influential people in general tend to be more involved in personal communication than others (Weimann et al., 2007, p. 175). Second, users in OSN like Facebook have up to several hundred of friends whereof only a very small portion actually interacts (Heidemann et al., 2010) and some users are actually totally inactive (Cha et al., 2010). Consequently, pure connectedness of users does not necessarily guarantee for influence (Goldenberg et al., 2009; Trusov et al., 2010, p. 646). Additionally, implicit connections that cannot be gathered via explicit friendship connections between users, for instance, explicated via voting, sharing, or bookmarking, can be captured by accounting for users' activity (Bonchi et al., 2011, p. 6). Third, new possibilities induced by the previously unknown amount of data on users' activity allows for incorporating users' activity as further factor. Accordingly, we analyzed the relevant

articles by means of the four (not mutually exclusive) factors “who one is”, “what one knows”, “whom one knows”, and “how active one is”. Table 2 illustrates the findings.

Overall, the majority of the relevant articles relies on rather broad definitions of influential users or stays imprecise about which characteristics are taken into account. Surprisingly, two factors (“who one is” and “what one knows”) are hardly considered, although Zhang et al. (2011, p. 1512) find that different topics (“what one knows”) lead to different results regarding the set of users that should be selected in order to influence most people in an OSN. In summary, we observe that current approaches barely consider user specific attributes as well as users’ knowledge on certain topics.

References	“Who one is”	“What one knows”	“Whom one knows”	“How active one is”
Aral and Walker (2012)	●	○	●	○
Canali and Lancellotti (2012)	○	○	●	●
Eirinaki et al., (2012)	●	○	●	●
Goldenberg et al., (2009)	○	○	○	●
Heidemann et al., (2010)	○	○	○	●
Hinz et al., (2011) ⁴	○	○	●	◐
Ilyas and Radha (2011)	○	○	●	●
Kim and Han (2009)	○	○	●	●
Kimura et al., (2007)	○	○	◐	◐
Lerman and Ghosh (2010)	○	○	●	●
Ma et al., (2008)	○	○	◐	◐
Narayanam and Narahari (2011)	○	○	◐	◐
Saito et al., (2012)	○	○	◐	◐
Trusov et al., (2010)	○	○	○	●
Zhang et al., (2010)	●	○	◐	◐
Zhang et al., (2011)	○	●	◐	◐
Not Considered ○ Considered ● Not further explicated ◐				

Table 2: Overview of the Characteristics Considered by the Relevant Articles

After the synthesis of how influential users are characterized within our set of articles, we examine the articles with respect to the proposed methods along with their evaluation and implications in the following.

Q.2 Which approaches have been developed and applied for the identification of influential users in OSN?

Q.3 How have these approaches been evaluated and which implications have been derived?

With respect to the two outlined major research streams (cf. section 2.3), six of the relevant articles apply approaches that are generally based on the strategic location of nodes in a graph (cf. Table 3). Since a static and potentially inactive social link (often so-called “friendship relationship”) in OSN does not guarantee an exchange of information and thus influence, Goldenberg et al. (2009) and Heidemann et al. (2010) define activity graphs where links between users do not represent friendship connections but the activity of nodes (e.g., messages, visits). Based on a directed activity graph, Goldenberg et al. (2009, p. 5) identify influential users by looking for hubs “[...] with in- and out-degrees larger than three standard deviations above the mean”. By analyzing Cyworld, the authors find that users with high degree centralities generally adopt earlier due to their large number of connections to other users. Furthermore, a user’s innovativeness was estimated in terms of adoption timing across multiple products. The authors differentiate innovators (who adopt before anyone else in the neighborhood) and followers (who compromise the rest) and thereby reveal that the former mainly influence the speed of adoption and the latter market size. Thus, Goldenberg et al. (2009, p. 10) conclude that hubs “[...] could be an efficient target for word-of-mouth campaigns, leading to both faster growth and increased market size”. Heidemann et al. (2010) define an undirected activity graph with weighted activity links representing the number of exchanged communication activities among users. By adapting the PageRank algorithm to account for the undirected and weighted graph, influential users are identified by means of high rankings among all users’ PageRank scores. The authors apply their approach to a Facebook dataset and show that their algorithm allows to identify more users that can be retained as active users in the future than when drawing on other centrality measures or users’ prior communication activity.

Besides these two articles focusing on the activity graph, the remaining four articles model a social graph consisting of social links, that is, friendship connections among users in OSN. Lerman and Ghosh (2010) argue that in general, dynamic social processes (e.g., information diffusion) as well as centrality measures to identify influential users can either be conservative (random walk-based) or non-conservative (broadcast-based). Since the diffusion of information is a non-conservative process, they hypothesize that accordingly non-conservative centrality measures (e.g., degree centrality, (normalized) α -centrality) perform better than conservative ones (e.g., PageRank, betweenness centrality). By analyzing a Digg dataset, Lerman and Ghosh (2010) confirm this hypothesis and find that in their case (normalized) α -centrality performs best. Hinz et al. (2011), however, find that targeting users in OSN with both high degree (non-conservative) and betweenness centrality scores (conservative) is particularly beneficial as well-connected users are more likely to participate in viral marketing campaigns. The authors

further observed that hubs do not have more influence on other users per se, they only use their greater reach more actively. In contrast to the so far discussed articles, Ilyas and Radha (2011) rather aim at identifying influential neighborhoods than single influential users. Therefore, they apply principal component centrality (PCC) in an undirected (weighted) social graph. Using the example of an Orkut and a Facebook dataset (in order to incorporate also user activity, the authors weight the social links by the number of users' interactions in the latter case), they show that in comparison to the application of eigenvalue centrality the number of identified influential neighborhoods and users can be increased by applying PCC. The authors further find that the tendency of eigenvalue centrality to identify a set of influential users within the same region of a massive graph of an OSN can be overcome by their proposed approach (Ilyas and Radha, 2011). Finally, Kim and Han (2009) propose to first rank users by their corresponding degree centrality scores in an undirected social graph. Second, the authors suggest identifying influential users by selecting the users with the highest centrality score and the highest activity index calculated as weighted the sum of selected activity indicators (e.g., number of groups, updated content per day). By analyzing the diffusion of a Facebook game, the authors find that targeting their identified influential users achieves increasing growth rates and higher number of new adopter than when addressing mediocrities (Kim and Han, 2009). Table 3 summarizes the approaches and findings.

References	Approaches and Findings
Goldenberg et al., (2009)	Propose to identify influential users by looking for hubs in a directed graph based on activity links . Define hubs as users "[...] with both in- and out-degrees larger than three standard deviations above the mean ". Analyze Cyworld and suggest targeting hubs, who lead to both faster growth and increased market size .
Heidemann et al., (2010)	Propose an adapted PageRank to identify influential users in an undirected and weighted graph based on activity links . Evaluate the approach by means of a Facebook dataset and find that more users that are retained can be identified than when users' prior communication activity (second best) or applying other centrality measures such as degree centrality (third best).
Hinz et al., (2011)	Propose degree and betweenness centrality to identify influential users in graphs based on social links . Apply different seeding strategies in anonymous OSN and customer networks. Find that hubs and bridges are more likely to participate in viral marketing campaigns and hubs use their greater reach more actively.
Ilyas and Radha, (2011)	Propose principal component centrality (PPC) to identify influential users at the center of influential neighborhoods in an undirected (weighted) graph based on social links . Apply their approach to Orkut and Facebook and find that in comparison to the application of eigenvector centrality the number of identified influential neighborhoods and users can be increased .

References	Approaches and Findings
Kim and Han, (2009)	Propose to identify influential users by first computing degree centrality in an undirected graph based on social links and second estimating an activity index . Evaluate their approach by means of the diffusion of a Facebook game. Find that targeting their identified influential users increases growth rates and leads to higher numbers of new adopters .
Lerman and Ghosh, (2010)	Propose (normalized) α-centrality to identify influential users in non-conservative diffusion processes in a directed (weighted) graph based on active social links . Evaluate the approach by means of a Digg dataset and find that the non-conservative model of (normalized) α-centrality performs better than conservative models of influence when identifying influential users in non-conservative processes such as information propagation .

Table 3: Articles Focusing on the Strategic Location of Users in OSN

Besides the six articles that apply approaches based on the strategic location of users in OSN (cf. Table 3), another six of all relevant articles focus on solving the influence maximization problem (top- k nodes problem) by different approximation algorithms (cf. Table 4). In contrast to the former ones, it becomes apparent that none of the latter ones, which will be discussed in the following, specifies whether the underlying directed or undirected graph is based on social or activity links. Four of the articles use SIR models (cf. section 2.3) to model the diffusion process. While Kimura et al. (2007) mainly focus on the design of an efficient approximation algorithm for the solution of the influence maximization problem based on bond percolation, Zhang et al. (2010) and Zhang et al. (2011) aim at incorporating more personal and social factors of influential users (cf. section 2.2) than solely their connectivity. Therefore, Zhang et al. (2010) incorporate similarity between users and Zhang et al. (2011) account for users' preferences for specific topics by weighting the graphs' links. Contrary to Kempe et al. (2003), Zhang et al. (2010) were able to show that due to richer information incorporated in the social graph, a degree-centrality-based algorithm performs often even better than the general and hill-climbing greedy algorithm. Narayanam and Narahari (2011) select a fundamentally different approach and suggest a Shaply value-based influential nodes (SPIN) algorithm based on an appropriately defined cooperative game. The authors show that their algorithm can not only solve the top- k nodes problem investigated in all articles displayed in Table 4, but also the λ -coverage problem, that is, finding a minimum set of influential nodes that influences a given percentage λ of nodes in the network. Furthermore, the authors show that their algorithm is more computationally efficient and yields a higher performance in terms of quality than the algorithms proposed by Kempe et al. (2003), Leskovec et al. 2007, and Chen et al. (2009). The article of Ma et al. (2008) differs as well from the previously discussed approaches. Instead of

using a SIR model, the authors model diffusion by a heat diffusion process. Thus, the approach can not only capture users that diffuse positive information but also negative influence on other users (even if these users already adopted e.g., a product). Moreover, their approach allows for planning marketing strategies sequentially in time, as a time factor is included. Besides Ma et al. (2008), also Saito et al. (2012) take into account the time factor. Therefore, the authors apply a susceptible/infected/susceptible (SIS) model and define a final-time and an integral-time maximization problem. While the first problem cares only about how many nodes are influenced at a point in time, the second problem focuses on the question of how many nodes have been influenced throughout a period of time. By solving the two problems with a greedy algorithm, Saito et al. (2012) find that more influential nodes can be discovered than by applying approaches based on centrality measures. Furthermore, the identified influential users differ remarkably depending on the chosen influence maximization problem. Therefore, the authors conclude that “[...] it is crucial to choose the right objective function that meets the need for the task” (Saito et al., 2012, p. 632). Table 4 summarizes the approaches and findings.

References	Approaches and Findings
Kimura et al., (2007)	Examine the influence maximization problem (top-k nodes problem) using SIR models (namely the IC and LT model) in a directed graph . Solve the problem under the greedy hill climbing algorithm on the basis of bond percolation and demonstrate a higher performance and a large reduction in computational cost in comparison to the conventional method that simulates the random process many times.
Ma et al., (2008)	Examine the influence maximization problem (top-k nodes problem) using a heat diffusion process in a directed and an undirected graph . Solve the problem under a top-k, k-step greedy , and enhanced k-step greedy algorithm . Apply their approach to an Epinion dataset and show that not only the diffusion of positive but also of negative information can be modeled. Furthermore, the included time factor allows for planning viral marketing campaigns sequentially in time.
Narayanam and Narahari, (2011)	Examine the influence maximization problem (top-k nodes problem) and the λ-coverage problem (finding a minimum set of influential nodes that influences a given percentage λ of nodes in the network) using a SIR model (namely LT) in a directed graph . Solve both problems by the Shaply value based influential nodes (SPIN) algorithm on the basis of a cooperative game . Show that the SPIN algorithm is more powerful and computationally efficient than existing algorithms.
Saito et al., (2012)	Examine the influence maximization problem (top-k nodes problem) using SIS models as final-time and integral-time maximization problem in a directed graph . Solve the problems under the greedy algorithm on the basis of bond percolation , pruning , and burnout . Find that more influential nodes can be discovered than by approaches based on centrality measures and that the identified influential users differ remarkably depending on the chosen problem.

References	Approaches and Findings
Zhang et al., (2010)	Examine the influence maximization problem (top-k nodes problem) using a SIR model (namely LT) in a directed graph . Adapt the LT model by weighting edges that account for similarity between users . Solve the problem by applying centrality , greedy , and combined algorithms . Apply their approach to an Epinion dataset and show that the graph built by “trust” and “review-rate” includes more information on the social network. Thus, a degree-centrality-based algorithm performs often even better than the general and hill-climbing greedy algorithm.
Zhang et al., (2011)	Examine the influence maximization problem (top-k nodes problem) using a SIR model (namely IC) in an undirected graph . Adapt the IC model by weighting edges that account users’ preferences for specific topics . Solve the problem under a CRLF optimized greedy algorithm including Monte Carlo simulation. Experimental results show that the approach significantly outperforms the traditional greedy algorithm in terms of information diffusion on specific topics .

Table 4: Articles Focusing on the Solution of the Influence Maximization Problem

Finally, four of the identified articles apply approaches for the selection of influential users in OSN which cannot be attributed to one of the two above mentioned research streams. The first article by Aral and Walker (2012) propose hazard models to measure the moderating effect of individual level attributes (e.g., gender, age) on influence, susceptibility, and dyadic peer-to-peer influence. By conducting a large scale in vivo randomized experiment in Facebook, bias by confounding effects, homophily, unobserved heterogeneity etc. could be eliminated (Aral and Walker, 2012). The results indicate that there are remarkable differences between the individual level attributes characterizing influencers and susceptibles. For instance, susceptibility decreases with age and women are less susceptible than men. Influence is also exerted mostly to users of the same age, men are more influential than women, and influential users cluster in the network. Taken together, Aral and Walker (2012, p. 340) highlight that (1) influential users need to be targeted, since they are unlikely to adopt due to influence by other users, (2) “[...] being influential is not simply a consequence of having susceptible peers [...]”, as diffusion depends on both influence and susceptibility, and that (3) “[...] targeting should focus on the attributes of current adopters [...] rather than attributes of their peers [...]”, since there are more users with high influence scores than with high susceptibility scores. Canali and Lancellotti (2012) as well differentiate and analyze “sources”, that is, users that propagate information that receives the most attention of other users, and “targets”, that is, users that access most information. The authors propose principal component analysis (PCA) to select and combine relevant user attributes (e.g., number of friends, number of comments). By applying their approach to a YouTube and Flickr dataset, they show that the approach is robust and effective, as it identifies more targets and sources than by applying in-degree centrality.

Eirinaki et al. (2012) apply a similar approach and suggest selecting and combining a set of profile-based characteristics representing popularity (e.g., number of friends, received comments) and activity (e.g., number of updates, last login time). By applying their approach to a synthetic and MySpace dataset, the authors find that influential users that might have been missed by betweenness centrality or PageRank can be identified as not only users' connectedness but also activity is taken into account. To account for the importance of users' activity, Trusov et al. (2010) suggest a nonstandard form of Bayesian shrinkage implemented in a Poisson regression, which is based on users' daily log-ins. The authors apply their approach to an anonymous OSN and find that only few social links of a user have actually influence on his or her behavior. They further show that their approach identifies more users that influence others' activity than simpler alternatives such as degree centrality or an approximation by the number of a user's profile views. Table 5 summarizes the approaches and findings.

References	Approaches and Findings
Aral and Walker, (2012)	Propose to identify influential users by applying hazard models to measure the moderating effect of individual level attributes on influence, susceptibility, and dyadic peer-to-peer influence. By conducting a large scale in vivo randomized experiment in Facebook it is shown that susceptible decreases with age , susceptibility increases with increasing relationship commitment until marriage, men are more influential than women , users exert most influence on other users of the same age , and influential users cluster in the network .
Canali and Lancellotti, (2012)	Propose to apply principal component analysis (PCA) to select and combine user attributes that allow for identifying influential nodes. Differentiate between " sources " and " targets ". Apply their approach to a YouTube and Flickr dataset to show that it is robust and effective. Find that their approach allows to identify more targets and sources than when applying in-degree centrality.
Eirinaki et al., (2012)	Propose to identify influential nodes by selecting and combining a set of profile-based characteristics representing popularity and activity. Apply their approach to a synthetic and MySpace dataset. Find that their approach allows for identifying influential users that might have been missed by betweenness centrality or PageRank as not only users' connectedness but also activity is taken into account .
Trusov et al., (2010)	Propose to identify influential nodes by a nonstandard form of Bayesian shrinkage implemented in a Poisson regression . Apply their approach to an anonymous OSN and find that only few social links of a user have actually influence on his or her behavior. Also their approach identifies more users that influence others' activity than simpler alternatives such as degree centrality or an approximation by the number of a user's profile views.

Table 5: Articles Focusing on Further Approaches

5. Future Research Directions

Online and offline social influence might not be the same.

Even though there have been first studies comparing offline and online social network constructs, such as tie strength (cf. e.g., Brown et al., 2007), many articles on the identification of influential users in OSN draw on theories and previous findings that have been originally derived in an offline context without critical reflection (cf. section 2.1). For instance, the visibility of social actions in OSN might lead to new forms of social influence, “[...] which rather than flowing from the actor to the observer, flows from the observer to the actor” (Sundararajan et al., 2012, p. 8). Thus, companies might be able to develop marketing strategies that “[...] incorporate targeting advisees, not just advisers”, as suggested by Hinz et al. (2013, p. 8). Future research should therefore especially focus on differences and commonalities of offline and online networks (Howison et al., 2011, p. 773). Are there differences between online and offline social systems, and if yes, what are these differences? Are online influencers also influential offline and vice versa? Are online traces reliable mirrors of offline social influence and contagion and does social influence invoked in online settings further spread into the offline world? More work regarding such questions should be encouraged and practitioners need to be aware that concepts developed offline might not work alike in online settings such as OSN.

BISE and Marketing could mutually benefit from more collaboration.

We find that most articles on the identification of influential users in OSN stem either from the scientific Business & Information Systems Engineering (BISE) or Marketing community. Taken together with our findings presented in section 4, it becomes apparent that marketing-oriented articles extensively draw on rich real-world datasets of OSN and even collaborate with OSN providers (cf. e.g., Trusov et al., 2010). In contrast, technical-oriented papers from the field of Computer Science and Engineering have a more theoretical approach and evaluate their artifacts in most cases by formal proofs, for instance regarding efficiency, run-time, or in a few cases apply synthetic or other networks’ data (e.g., authorship networks) (cf. e.g., Narayanam and Narahari, 2011). This may account for the fact that some of the central findings of these rather design-oriented articles are contrary to empirical findings from the Marketing community (e.g., regarding the applicability of degree centrality for the identification of influential users in OSN). Therefore, we believe that an even stronger collaboration between the scientific BISE and Marketing community than we find today could be mutually beneficial by exchanging data on OSN, knowledge about efficient and automated algorithms that actually can handle the vast

amount of data in OSN, or contacts to OSN providers. Furthermore, the actual design and implementation of algorithms in cooperation with companies or OSN providers, for instance by conducting Action Design Research (cf. Sein et al., 2011), could be facilitated in future research. To do so, however, access and privacy challenges need to be overcome in order to acquire reliable data (Howison et al., 2011, p. 775; Lazer et al., 2009, p. 722). Therefore, “[r]obust models of collaboration and data sharing between industry and academia are needed” and “[r]esearchers themselves must develop technologies that protect privacy while preserving data essential for research” (Lazer et al., 2009, p. 722).

A human being and his or her behavior are not just nodes and links in a graph.

The majority of the articles do neither incorporate personal information on users that allows for assessing “who one is” or “what one knows” (cf. Table 2). However, Trusov et al. (2010, p. 645) and Hinz et al. (2011, p. 68), for instance, find that having many friends (i.e., social links) does not make users influential per se. Thus, focusing solely on “whom one knows” (cf. Table 2) might not be sufficient to identify influential users in OSN. Instead, there is remarkable heterogeneity among users in OSN, that is, the average user is influenced by relatively few other users and in turn, influences few other users (Trusov et al., 2010, p. 645). Prior research states that “[...] influence [...] cannot be simply traced back to the graph properties [...] but also depends on the personality and emotions of the human being behind it” (Quercia et al., 2011, p. 1). Furthermore, it has been emphasized that influence is not a “[...] unidimensional measure, but a combination of personal traits with social network positioning [...]” (Weimann 1991, p. 276). However, empirical studies of how individual attributes of users moderate influence can hardly be found. A first study by Aral and Walker (2012) finds that influence and susceptibility of users heavily depends on the individual level attributes of users (e.g., age, gender). This is also confirmed by Katona et al. (2011), who find that some demographic variables are good predictors of adoption. On the other hand, influence is often overestimated, as homophily actually accounts for a large share of social contagion (cf. section 2.3). Zhang et al. (2011) emphasize that the identification of influential users also depends on users’ preferences for specific topics as the diffusion of information differs among topics (cf. e.g., Saito et al., 2009; Saito et al., 2010). Thus, practitioners targeting influential users in OSN should take into account not only the specific characteristics of the users but also of their advertised products and services. We consequently believe that more research is needed to investigate the relationships between the personal and social factors of influential users, the distribution of these factors across users, and the homophily in the formation of social and activity links in OSN. With respect to these links, also questions regarding the selection and

combination of different link types (e.g., social and activity links), their intensity (e.g., denoted by weights based on the number of communication activities, cf. Heidemann et al., 2010), and the role of missing links (e.g., does the absence of traces for a link in the dataset under consideration provide evidence for the absence of social influence?) should be addressed in more detail in future research (Howison et al., 2011).

Not just positive information might be propagated.

Besides the article by Ma et al. (2008) (cf. Table 4), none of the analyzed articles explicitly models the diffusion of positive *and* negative information in OSN. However, prior research on word-of-mouth in general found that negative word-of-mouth is more likely and stronger than positive word-of-mouth (Anderson, 1998; Bone, 1995): While on average dissatisfied customers can be expected to tell eleven persons, satisfied only tell about five persons about their experiences (Heskett et al., 1997). Thus, negative word-of-mouth is about twice as likely as positive word-of-mouth (Mangold et al., 1999). Also in an online context, Chevalier and Mayzlin (2006) found that the impact of a negative review on sales was greater than the impact of a positive one and Berger and Milkman (2012) showed that content provoking negative emotions such as anger or anxiety tended to be exceptionally viral. Therefore, practitioners need to be aware that targeting influential users in OSN can also incorporate a certain risk of negative information diffusion. In order to better understand the role of influential users propagating negative information in OSN, future research should also develop diffusion models that incorporate a certain degree of (influential) users that do not solely or doubtless spread positive information.

The one who leads might not follow.

Most of the discussed approaches (cf. section 4) try to identify the most influential users that should be targeted in order to maximize the impact of a marketing campaign. However, as Watts and Dodds (2007, p. 442) state, “[...] it is generally the case that most social change is driven not by influentials but by easily influenced individuals influencing other easily influenced individuals”. Aral and Walker (2012) point out that the susceptibles hypothesis is for instance well represented in theoretical threshold-based models (cf. section 2.3), which are also used by some of the approaches discussed in section 4 (cf. Table 4). However, besides Aral and Walker (2012) and partly Canali and Lancellotti (2012), none of the discussed articles analyzes the role of susceptibles in depth. Particularly behind the backdrop of the findings of Aral and Walker (2012) outlined in section 4, it still seems to be promising for practitioners to address influential users in OSN, but further research is needed to enrich our understanding of the role of

susceptibles and their individual characteristics as well as their interplay with influential users in OSN (cf. e.g., Hinz et al., 2013).

You are not alone.

None of the discussed articles considers optimal seeding strategies in a competitive environment. However, due to the sheer size and the high number of connections to other users in OSN, isolated diffusion processes may not be representative for reality. Furthermore, users in OSN are exposed to a tremendous amount of information (Canali and Lancelotti, 2012, p. 29). This information overload may cause users in OSN to be less easily influenced as they simply cannot process all the information that they are exposed to (Hinz et al., 2011, p. 58). Therefore, practitioners need to be aware that competing marketing campaigns or information overload may diminish the effects of viral marketing campaigns. We believe that further research is needed to better understand the consequences of parallel (competing) viral marketing campaigns, for example regarding different products of one company or simultaneous marketing campaigns of different companies, and the impact of information overload.

Degree centrality is not that bad.

Our analysis shows that most articles focusing on the solution of the influence maximization state that their approaches outperform simpler approximations such as degree centrality (cf. Table 4). However, this is in contrast to a number of articles, which find that particularly users with high degree centrality scores (i.e., hubs), are in fact the influential users in OSN (cf. Table 3). This finding is also verified by Zhang et al. (2010), who show that degree centrality-based algorithms perform often even better than greedy algorithms when approximating the optimal solution of the influence maximization problem. This might be due to richer information, which is incorporated in social graphs of OSN (Zhang et al., 2010). Also Tang and Yang (2010) find in a similar context that a simple degree centrality based algorithm performs almost as good a complex PageRank based approach. One explanation for these deviating results could be the different evaluation methods as outlined above. In line with related studies (e.g., Kiss and Bichler, 2008) we find that degree centrality can be a reasonable measure for the identification of influential users in OSN. However, practitioners targeting users with high degree centrality scores need to be aware of further findings, which indicate that the influential power of users and susceptibility decreases with a rising number of contacts (e.g., Katona et al., 2011; Narayan et al., 2011). Moreover, some articles indicate that users with high degree centrality scores do not have higher conversion rates due to a higher persuasiveness but are

rather more active (e.g., Hinz et al., 2011; Iyengar et al., 2011b). Thus, further research on the optimal centrality of influential users, the actual role of social influence in OSN, and further validations using large-scale data from actual OSN should be encouraged.

Methods, diffusion processes, and network properties need to be aligned.

As Lerman and Ghosh (2010) point out, the diffusion of information is a non-conservative process. However, not only the diffusion process but also centrality measures make implicit assumptions about the nature of the diffusion process (Borgatti, 2006). Therefore, the actual underlying diffusion process affects the applied approaches (Ghosh et al., 2011), which hence need to be aligned accordingly. However, for instance Hinz et al. (2011, p. 69) find that it is beneficial to target users with high betweenness centrality scores. This is a conservative centrality measure (Lerman and Ghosh, 2010) applied in the context of viral marketing campaigns, whereby diffusion is usually considered as a non-conservative process (Ghosh et al., 2011). Furthermore, Narayanam and Narahari (2011, p. 145) find that “[t]he presence of communities strongly affects the process of identifying influential nodes”. This is in line with findings by Kimura et al. (2008), who found that certain community structures are strongly correlated with the greedy solution of their influence maximization problem under the IC model. Ilyas and Radha (2011) go one step further and identify users that form centrality maxima within influential neighborhoods. This is a promising approach for future research, as it is hardly the case that there is only a single influential neighborhood in OSN with millions of users. Consequently, several users might have relatively low influence scores compared to the whole OSN, but relatively high influence scores within their relevant neighborhoods. Therefore, practitioners and researchers should carefully consider and align their applied methods and approaches to the underlying diffusion processes and network properties when identifying influential users in OSN (cf. Howison et al., 2011, p. 790 f.). However, since not all studies confirm the propositions of Lerman and Ghosh (2010), further research should be encouraged to achieve a deeper understanding about the interplay of centrality measures and diffusion processes.

Efficiency and validity are crucial.

Taking a look at the articles focusing on the solution of the influence maximization problem by using diffusion models and solving them by (greedy) algorithms (cf. Table 4), it becomes apparent that the efficiency of the applied algorithms is a crucial success factor for their applicability in a real-world context (Saito et al., 2012). Therefore, as discussed above, solutions based on well-established centrality measures from SNA are often favorable, even though more

sophisticated algorithms might be more accurate (cf. e.g., Zhang et al., 2011). However, the application of SNA in new contexts such as OSN raises several challenges and corresponding validity issues (cf. Howison et al., 2011 for an overview). For instance, building an activity graph requires the aggregation of activity links over time (cf. e.g., Heidemann et al., 2010). This might lead to “[...] networks with different structural properties than the network experienced by participants” (Howison et al., 2011, p. 784), which offers starting points for future research. Taken together, practitioners and researchers need to be aware of the trade-off between high accuracy as well as validity and sufficient efficiency for large-scale datasets of OSN. Further research could thus also address questions of optimal levels of accuracy and efficiency from an economical perspective when identifying influential users for marketing purposes in OSN.

6. Conclusion

Who will lead and who will follow? The question of identifying those people that mobilize and propagate influence in networks and society the most effective way has been intensively analyzed in different research streams over the last decades. Along with the explosive growth of OSN, related changes regarding access and availability of user data, a decreasing impact of traditional marketing techniques, and changes in customer behavior, identifying influential users in OSN received a great deal of attention in recent years. With this context at hand, we focused on identifying relevant publications by means of a structured literature search in order to analyze, synthesize, and assess applied characteristics of and methods for identifying influential users in OSN. It is hoped that the results can stimulate and guide future research in the field.

However, our findings are subject to limitations: First, despite we conducted a broad and structured database search there is still a certain chance that not all relevant articles have been identified. Furthermore, we selected appropriate search terms derived from literature, but nevertheless additional phrases might have also uncovered a few more relevant papers. Second, by our focus on OSN we excluded articles that analyze content-oriented sites such as Twitter or YouTube. Thus, our perspective is narrowed and certain approaches and findings that have only been researched on such sites are not considered. Future research could build upon the presented findings when first extending the analysis to also content-oriented sites and second investigating commonalities and differences regarding the identification of influential users in content-oriented sites and OSN. Additionally, the focus on influential users in OSN could be broadened in the future in order to discuss also commonalities and differences of social influence in online and offline settings. Further research might therefore apply a broader

definition of OSN and incorporate also studies on offline networks. Besides these limitations, we hope that our findings help interested parties from BISE, Marketing, and beyond to get a first overview and better understanding of the body of knowledge regarding the identification of influential users in OSN. Additionally we hope to provide directions for future research in this field.

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Research Paper 3: “More Fans at any Cost? Analyzing the Economic Effects of the Ratio of Fans to Non-Fans in a Customer Portfolio Considering Electronic Word-of-Mouth”

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Abstract: Consumers in Online Social Networks increasingly rely on electronic word-of-mouth (eWOM) when making purchase decisions. Recent research suggests positive effects of the resulting strong exposure of fans to eWOM on cash flows leading companies to follow the popular belief that they should grow their number of fans to the maximum by intensively promoting their fan pages. However, even though the sentiment of eWOM is prevalingly positive, a sheer maximization of the share of fans in a customer portfolio must be critically reflected: while fans yield higher expected cash flows than non-fans, also the associated risks in terms of these cash flows' volatility might be considerably higher. Thus, diversifying risk by keeping a share of non-fans – or even increasing it – might be economically reasonable. By drawing on a Portfolio Selection Theory based model and real-world data, this paper analyses the ratio of fans to non-fans in a customer portfolio.

1. Introduction

Online Social Networks (OSN) have revolutionized interpersonal communication (Heidemann et al., 2012) and became highly significant for the marketing communication mix of companies (Albuquerque et al., 2012; Faase et al., 2011; Rishika et al., 2013). This significance results particularly from extensive electronic word-of-mouth (eWOM) that is generated by the rising number of active users in OSN and dispersed with previously unknown reach, intensity, and speed. For instance, solely on Facebook almost 1.2 billion monthly active users (Facebook, 2014) share 684,478 pieces of content and ‘like’ 34,722 brands or organizations – every single minute (Tepper, 2012).

(Potential) customers increasingly rely on such eWOM generated by other customers when searching for information about products or services (Moon et al., 2010) or help in purchasing decisions (Chen and Xie, 2008). Therefore, it is not surprising that many companies host so-called ‘fan pages’ (Kim et al., 2010; Rishika et al., 2013), which enable (potential) customers to generate eWOM by creating comments, wall posts, or likes. In March 2013, the number of such fan pages on Facebook had already grown to over 15 million (Koetsier, 2013). To further maximize the impact of their fan pages, companies approach and incentivize (potential) customers to get connected to their fan pages by becoming so-called ‘fans’. Thus, a close link between the fan page and their fans is established (Harris and Dennis, 2011; Poynter, 2008) and eWOM generated on the fan page is automatically pushed into the news feeds of all fans (Debatin et al., 2009; Gallagher and Ransbotham, 2010). Recent studies suggest positive effects of the resulting strong exposure of fans to eWOM on their cash flows (Goh et al., 2013; Rishika et al., 2013). Consequently, many companies follow the popular belief that they should grow the number of fans to a maximum extent, for instance, by intensively promoting their fan pages (McEleny, 2011; O’Reilly, 2013).

However, the positive effects of a high exposure to eWOM hold only true, if the sentiment is positive. Even though the sentiment of eWOM generated on fan pages is prevalingly positive (Rishika et al., 2013; Scholz et al., 2013), in case of eWOM with negative sentiment, the news feed mechanism of fan pages also accelerates and intensifies the exposure of fans to negative eWOM, whereas non-fans, who are not connected with the fan pages, are not affected as directly and intensively. Following the results of current studies, the stronger exposure to negative eWOM may consequently lead (on average) to a stronger decrease of the cash flows generated by fans compared to those generated by non-fans, who are not directly exposed to mood swings on fan pages (cf. Chevalier and Mayzlin, 2006; Liu, 2006). Hence, as indicated by empirical

studies and outlined above, fans not only yield higher expected cash flows (than non-fans), but also the associated risks in terms of these cash flows' volatility might be considerably higher. As a consequence, a sheer maximization of the share of fans in a customer portfolio must be critically reflected. Rather, we suggest that it might be economically reasonable to keep a share of non-fans in order to diversify the risk in terms of a higher volatility of fans' cash flows. Existing approaches demonstrated how risks in customer portfolios can be diversified in general by applying Portfolio Selection Theory (e.g., Buhl and Heinrich, 2008; Sackmann et al., 2010; Tarasi et al., 2011). However, none of these approaches has been applied on the research subject at hand before. We thus undertake a first step bringing together prior work from research on customer portfolio optimization and preliminary empirical findings on eWOM to investigate the economic effects of the ratio of fans to non-fans in customer portfolios.

Meredith et al. (1989, p. 301) suggest that "[...] all research investigations involve a continuous, repetitive cycle of description, explanation, and testing (through prediction)". Research activities dedicated to the *description* stage examine research fields first and provide "[...] a well-documented characterization of the subject of interest" (Meredith et al., 1989, p. 301). In this sense, we aim at contributing to fundamental insights by gathering and structuring preliminary empirical results on the economic effects of eWOM by fans and non-fans. *Explanation* refers to research deriving generalized frameworks, concepts, or analytical models on the basis of a *description* and is the research stage we focus on in this paper. As core artifact, we bring together preliminary findings from cross-disciplinary research in a novel manner: in line with Gregor and Hevner (2013, p. 347), who state "[...] that effective artifacts may exist in related problem areas that may be adapted [...] to the new problem context", we adapt customer portfolio optimization to account for preliminary empirical findings on the economic effects of eWOM of fans and non-fans. Adapting existing artifacts "[...] is common in IS, where new technology advances [such as OSN] often require new applications (i.e., to respond to new problems) and a consequent need to test or refine prior ideas" (Gregor and Hevner, 2013, p. 347). By this means, we aim at providing a basis for hypothesis generation and testing in further research.

The paper is structured as follows: in the next section, we first outline the problem context, discuss preliminary empirical findings on the economic effects of eWOM generated in OSN, and provide an overview of current studies on customer portfolio optimization. We conclude with the research gap. In the subsequent section, we develop a model for the analysis of the economic effects of the ratio of fans to non-fans in customer portfolios. Afterwards, we demonstrate the validity and utility of our model in a case example based on real-world data of

an online retailer as well as publicly available data. We thereby show that eWOM significantly influences the cash flows of fans while non-fans are less affected. Additionally, we run a sensitivity analysis to evaluate the robustness of our model. Finally, we summarize our results and provide an outlook on future research as foundation for model extensions in the course of further iterations, in line with an ongoing research cycle (Meredith et al., 1989).

2. Background and Related Work

In the following section, we first provide relevant information on the research background and second review related work regarding the influence of eWOM generated in OSN on both, the company value in general and on the customer value in particular. Third, we briefly discuss the state of the art of customer portfolio optimization with respect to our research objective. Finally, we explicate the research gap.

2.1. Background on eWOM in Online Social Networks

For decades, research emphasizes that traditional, interpersonal word-of-mouth (WOM) is the most important source of information for purchase decision making (Katz and Lazarsfeld, 1955), being more influential than other, marketer-controlled sources (Buttle, 1998). In today's increasingly interconnected world, information is no longer only spread interpersonally by WOM but also electronically via the Internet (Dellarocas, 2003; Goh et al., 2013). We define such eWOM in line with Henning-Thurau et al. (2004, p. 39) as "[...] any positive or negative statement made by potential, actual, or former customers about a product or company, which is made available to a multitude of people and institutions via the Internet". The literature shows that this eWOM has an exceptionally high influence on purchase decision making. That is as, first, customers consult and trust eWOM more than marketer-generated content (Chen and Xie, 2008; Dellarocas et al., 2007; Moon et al., 2010; Narayan et al., 2011) and second, eWOM is spread with higher speed, reach, and immediacy than WOM before purchase decisions take place (Henning-Thurau et al., 2004; Li and Zhan, 2011).

OSN have even reinforced and accelerated the spread of eWOM (Dellarocas, 2003) by offering a livelier and more direct interaction between (potential) customers and companies, and particularly among customers themselves (Bonchi et al., 2011; Brock et al., 2011). According to Boyd and Ellison (2013, p. 158), we define an OSN as a "[...] networked communication platform in which participants 1) have uniquely identifiable profiles that consist of user-supplied content, content provided by other users, and/or system-provided data; 2) can publicly articulate connections that can be viewed and traversed by others; and 3) can consume, produce, and/or interact with streams of user-generated content provided by their connections on the site

[usually via a so-called news feed]”. While OSN were originally designed for private users (Bughin and Manyika, 2007), they nowadays also attract large numbers of companies that perceive them as a perfect platform for communicating directly with their (potential) customers (Heidemann et al., 2012; Nagle and Pope, 2013). Customers now even expect companies being present in OSN and using them as communication platform such that they became almost inevitable for improving customer relationships and brand perceptions (Dutot, 2013). To do so, companies increasingly launch corporate profile pages, so-called ‘fan pages’ (Kim et al., 2010; Wen et al., 2009), and create marketer-generated content with the goal of simultaneously promoting their brands and advertising specific products or services (Scholz et al., 2013). To leverage the potential of eWOM, fan pages offer customers the possibility to express their opinions by creating new content or by commenting, liking, or sharing existing content. The fact, that customers actually expose themselves voluntarily to brand information by choosing to become a fan by themselves makes this eWOM on fan pages more influential and accelerates and facilitates its distribution even more (Chu and Kim, 2011). Because of the push mechanism of fan pages, where content is pushed immediately into the news feeds of fans, on the contrary to non-fans, they are on a regular basis subject to this even more immediate form of eWOM. As not connected to the fan page, non-fans do not have that direct link and are therefore less or even not at all exposed to company-related eWOM. For non-fans receiving the same information in the identical density would therefore take much more effort and time. Due to the high potentially positive influence of eWOM on customers and the property of fan pages to even reinforce this influence on fans, many companies follow the popular belief that they should grow their number of fans to a maximum extent, for instance, by intensively promoting their fan pages (McEleny, 2011; O’Reilly, 2013).

2.2. Economic Effects of eWOM Generated in Online Social Networks

With the increasing impact of eWOM on purchase decision making (cf. section 2.1), a plethora of research began emphasizing that companies need to consider the economic effects of eWOM generated in OSN, which substantially influence the company value in general and the value of customers in particular (Algesheimer and von Wangenheim, 2006; Hogan et al., 2003; Kumar et al., 2010; Nitzan and Libai, 2011; Oestreicher-Singer et al., 2013). What is the reasoning behind the relationship between eWOM, customer values, and the value of companies?

First, it is generally acknowledged in the literature that customer relationships account for a considerable share of the company value in many companies (Gupta et al., 2004; Kumar et al., 2004). While many ways to measure the value of customers have been suggested (for an overview cf. e.g., Gupta and Zeithaml, 2006), it is predominantly the customer lifetime value – generally defined as “the present value of all future profits generated from a customer” (Gupta and Lehmann, 2003, p. 10) – that has become an intensively researched and widely accepted concept (Pepe, 2012).

Second, prior (mainly conceptual) work has emphasized that customer retention and profitability (i.e., the ratio of revenues to costs) are two key components of the customer lifetime value (Stahl et al., 2012), which can be influenced by eWOM (Algesheimer and von Wangenheim, 2006; Kaske et al., 2012; Ryals, 2003; Weinberg and Berger, 2011).

Third, empirical research has shown that cash flows and related economic measures (e.g., revenues, sales rank, conversion rates, or profitability) are indeed influenced by both, the volume and sentiment of eWOM generated in OSN. A multitude of existing literature (cf. Table 1) confirms a positive influence of an increased volume of eWOM as well as a positive (negative) influence of eWOM with positive (negative) sentiment on cash flows or related measures (analyses based on both aggregated as well as individual product and customer data).

Author(s)	Context	Dependent variable	eWOM volume	eWOM sentiment	
				Positive	Negative
Chen et al. (2004)	Books	Sales rank	+	+	-
Chevalier and Mayzlin (2006)	Books	Sales rank	+	+	-
Chintagunta et al. (2010)	Movies	Revenue	x	+	-
Dhar and Chang (2009)	Music	Sales rank	+	+	-
Duan et al. (2008)	Movies	Revenue	+	+	-
Liu (2006)	Movies	Revenue	+	+	-
Ludwig et al., (2013)	Books	Conv. rate	+	+	-
Luo (2009)	Airlines	Cash flow	x	x	-
Moe and Trusov (2011)	Beauty products	Revenue	+	+	-
Sonnier et al. Rutz (2011)	Tech. products	Revenue	x	+	-
Goh et al., (2013)	Apparel retailer	Revenue	+	+	-
Rishika et al., (2013)	Wine retailer	Profitability	+	+	x
<input type="checkbox"/> Analysis based on aggregated customer/product data, <input type="checkbox"/> analysis based on customer/product individual data, + positive influence, - negative influence, x no influence/not investigated					

Table 1: Relationship between the volume and sentiment of eWOM and revenues

To leverage the positive effect on cash flows of both, an increased volume of eWOM and eWOM with positive sentiment (cf. Table 1), companies approach and incentivize (potential) customers to get connected to their fan page by becoming fans (Rishika et al., 2013). This opt-in mechanism establishes a close link between the fan page and their fans (Harris and Dennis, 2011; Poynter, 2008), as eWOM generated on the fan page is automatically pushed in real-time into the news feeds of all fans (Debatin et al., 2009; Gallagher and Ransbotham, 2010). Thus, fans are on average exposed to a higher volume of eWOM than non-fans. Moreover, as the users of OSN engaging on fan pages are usually particularly strong admirers of the respective companies and brands (Muniz and O'Guinn, 2001; Rishika et al., 2013), the sentiment of content produced on fan pages is mainly positive (Goh et al., 2013; Rishika et al., 2013; Scholz et al., 2013). Therefore, fans are usually not only exposed to a higher volume of eWOM, but also to eWOM with prevalingly positive sentiment. Taken together, prior research shows that fans are exposed to a higher volume of eWOM with mainly positive sentiment, leading to higher expected per capita cash flows generated by fans than those generated by non-fans (Rishika et al., 2013).

However, prior empirical findings indicate, that the per capita cash flows generated by fans are also more volatile: first, eWOM generated on fan pages can be negative as well (cf. e.g., Scholz et al., 2013) and according to existing research, eWOM with negative sentiment has a negative effect on cash flows and related economic measures (cf. Table 1). That is because, as already stated above, admirers of the companies have strong positive feelings towards the products. But

intense positive emotions also allow for extreme lows when confronted with negative events (Strack et al., 1991), such as negative eWOM. Additionally, a fan page is one of the main channels for disappointed customers to complain and displeased customers commit much more energy spreading their negative experiences than delighted customers their positive (Champoux et al., 2012). Second, as in the case of eWOM with positive sentiment, the news feed mechanism of fan pages also accelerates and intensifies the exposure of fans to eWOM with negative sentiment. Although negative eWOM generated on fan pages can also be transferred to non-fans by face to face communication or other channels, the cash flows generated by fans on average decrease stronger than those by non-fans, as – due to the news feed mechanism – negative eWOM spreads instantaneously and automatically to all fans (cf. e.g., Chevalier and Mayzlin, 2006; Liu, 2006).

Taken together, based on existing literature, the expected cash flows generated by fans are assumed to be higher in comparison to non-fans, but they might also be more volatile, which implies a risk for the company. For instance Dhar and Glazer (2003) as well as Ryals (2002; 2003) point out, that when valuating customer portfolios, such risks associated with single customers or customer segments need to be considered, i.e. in this context the risk in terms of the volatility of the expected per capita cash flows generated by fans.

2.3. Customer Portfolio Optimization

Analogous to the case of financial portfolios, such differences in the risk/return structure of single customers or customer segments (here: the segments of fans and non-fans) enable companies to utilize diversification effects. Consequently, several existing studies already demonstrate the applicability of Markowitz's Portfolio Selection Theory (Markowitz, 1952; 1959) in the context of customer portfolio management (Buhl and Heinrich, 2008; Sackmann et al., 2010; Tarasi et al., 2011). Buhl and Heinrich (2008), for instance, differentiate customer segments according to customers' professions and conclude that imperfect correlations between segments (as given in our case by the differing exposure of fans and non-fans to eWOM) allow for diversifying risk in customer portfolios. Tarasi et al. (2011) build on these considerations and exploit general customer heterogeneity to improve value creation in customer portfolios. Sackmann et al. (2010) distinguish loyal, relationship-oriented, and transaction-oriented customers and find that individual customer behavior can be better predicted and strategic target group considerations (here: the promotion of fan pages to grow the share of fans in a customer portfolio) are facilitated by their segmentation approach. Ryals et al. (2007) even propose a customer portfolio optimization approach to explicitly support marketing budget allocation

decisions. Summing up, several existing studies already demonstrated the applicability of Portfolio Selection Theory in the context of customer portfolio management in order to diversify risks (Buhl and Heinrich, 2008; Sackmann et al., 2010; Tarasi et al., 2011) and to guide the allocation of marketing budgets (Ryals et al., 2007).

2.4. Research Gap

According to the paradigm of value-based management (Coenenberg and Salfeld, 2007), which postulates “[...] the maximization of the long-term sustainable enterprise value as a guideline for all business activities” (Buhl et al., 2011, p. 164), the popular belief that companies’ marketing efforts should aim at turning a maximum share of their customers to fans must be critically reflected: while fans yield higher expected cash flows than non-fans (cf. e.g., Rishika et al., 2013), also the associated risks in terms of these cash flows’ volatility might be considerably higher. Thus, diversifying this risk by keeping a share of non-fans – or even increasing it – might be economically reasonable. However, to the best of our knowledge, approaches for the optimal allocation of a company’s customers to the segments of fans and non-fans in a value-based manner are missing. Therefore, we suggest a model for the analysis of the economic effect of the ratio of fans to non-fans in a company’s customer portfolio in the following.

3. Customer Portfolio Optimization Model

Even though the focus of this paper is on these two segments (fans and non-fans), we state the model in a general form, thus making it easy to incorporate more customer segments. This could be applicable in further, consecutive research considering a finer grained segmentation based on further customer characteristics such as age or income level. In line with prior work on customer portfolio optimization (e.g., Buhl and Heinrich, 2008; Tarasi et al., 2011), we assume:

(A1) The segments $i = 1, 2, \dots, I$ determine the whole customer portfolio consisting of $N \in \mathbb{N}$ customers at the time of optimization $t = 0$. The portfolio share $w_i \in [0,1]$ of each segment i is denoted by the ratio of the number of customers in the segment $n_i \in \mathbb{N}$ and the total number of customers in the portfolio N . The portfolio shares w_i are the decision variables of the customer portfolio optimization in $t = 0$ for the whole planning horizon T . Therefore, we state:

$$\sum_{i=1}^I n_i = N, \quad w_i = \frac{n_i}{N} \quad \forall i, \quad \sum_{i=1}^I w_i = 1. \quad (1)$$

The customers in each segment i generate periodic cash flows, which are influenced by several factors such as customer characteristics, price, and marketing efforts. When optimizing the ratio of fans to non-fans, a factor of particular influence needs to be considered, namely eWOM (cf. e.g., Goh et al., 2013; Rishika et al., 2013; Scholz et al., 2013). As discussed in the previous section, prior empirical research identified two main aspects of eWOM influencing cash flows, that is, its volume and sentiment (cf. Table 1). Rishika et al. (2013), for instance, confirm a higher profitability of fans compared to non-fans due to the higher volume of eWOM they are exposed to. Regarding the sentiment of eWOM, Rishika et al. (2013) also confirm a higher profitability of fans compared to non-fans due to their higher exposure to eWOM with positive sentiment. Taken together, as fans are first exposed to a higher volume of eWOM than non-fans and second to eWOM with prevailing positive sentiment, the expected cash flows of fans should be higher in comparison to non-fans. Consequently we assume:

(A2) All customers in a segment i generate (average) per capita net cash flows $\widetilde{CF}_{i,t} \in \mathbb{R}$ in period t , representing revenues minus direct variable costs (e.g., average costs for the services or products sold). In line with prior research (cf. Table 1), we state a direct relationship¹ between the volume and sentiment of eWOM and the per capita net cash flows $\widetilde{CF}_{i,t}$ ², which are assumed to be independent and identically distributed (i.i.d.) random variables given in $t = 0$ (cf. e.g., Buhl and Heinrich, 2008).

Costs and the time value of money need to be considered when optimizing customer portfolios in a value-based manner (Buhl and Heinrich, 2008; Ryals, 2002; 2003). One metric that fulfils these requirements is the customer lifetime value, which is widely accepted for valuing the customer base of companies in general (Gupta et al., 2004; Kumar et al., 2004) and for valuing marketing budget allocation decisions such as the promotion of fan pages in particular (Kaske et al., 2012; Ryals et al., 2007). With respect to costs, all variable costs depending on the optimal portfolio shares w_i are included in the per capita net cash flows (cf. assumption A2). Fixed costs that occur independently of our customer portfolio considerations and cannot be assigned to a segment i (e.g., general administration costs) do not influence the decision on the optimal portfolio shares w_i and are therefore not considered in the following. As we assume that all

¹ Our model draws on the positive (negative) effects of positive (negative) eWOM on cash flows only implicitly within this first research step. For a potential function that could be used to model this relationship explicitly see for instance Weinberg and Berger (2011).

² With respect to our focus on the segments of fans and non-fans and the influence of eWOM, all further factors potentially influencing their respective cash flows (e.g., customer characteristics such as age or income level) are assumed to be deterministic and equal for both segments.

segments i are fixed over the planning horizon T (cf. assumption A1), further fixed costs that can be assigned to a segment i but do not depend on the number of customers n_i in this segment (e.g., costs for hosting a fan page) can also be neglected (Buhl and Heinrich, 2008)³. To account for the time value of money, the per capita customer lifetime value \widetilde{CLV}_i of customers in segment i sums up the net present values of the per capita net cash flows $\widetilde{CF}_{i,t}$ over the planning horizon T , whereby r_f represents the risk-free rate of return:

$$\widetilde{CLV}_i = \sum_{t=0}^T \frac{\widetilde{CF}_{i,t}}{(1+r_f)^t} . \quad (2)$$

The expected per capita customer lifetime value $E(\widetilde{CLV}_i)$ of segment i (shortly: μ_i) is given by:

$$\mu_i = E(\widetilde{CLV}_i) = \sum_{t=0}^T \frac{E(\widetilde{CF}_{i,t})}{(1+r_f)^t} . \quad (3)$$

On the basis of assumption (A1) and Formula (3), the expected per capita portfolio return $E(\widetilde{CLV}_{PF})$ (shortly: μ_{PF}) can be calculated as the weighted sum of the expected customer lifetime values per capita μ_i over all segments I (cf. e.g., Buhl and Heinrich, 2008):

$$\mu_{PF} = E(\widetilde{CLV}_{PF}) = \sum_{i=1}^I w_i \mu_i . \quad (4)$$

So far, our model incorporates the expected per capita net cash flows of customers in different segments. However, as discussed in the previous section, also risks associated with customer segments need to be considered when valuating customer portfolios (Dhar and Glazer, 2003; Ryals 2002; 2003). In our context, risk is induced by the fact that eWOM generated on fan pages can be positive as well as negative (cf. e.g., Goh et al., 2013; Scholz et al., 2013) and not only eWOM with positive sentiment has a positive effect on cash flows, but also eWOM with negative sentiment has a negative effect on cash flows (cf. Table 1). Taken together, the consideration of risk, that is the deviation of cash flows from their expected value, is necessary. To do so, the standard deviation has been suggested in literature on the optimization of customer portfolios (Buhl and Heinrich, 2008; Ryals et al., 2007; Sackmann et al., 2010; Tarasi et al., 2011). We consequently assume:

³ From a value-based management perspective, the net present values of all normalized per capita fixed costs should at least be covered by the expected per capita portfolio return given in Formula (4).

- (A3) The risk associated with the per capita net cash flows $\widetilde{CF}_{i,t}$ of each segment i in period t is quantified by the standard deviation $\sigma_{i,t} = \sqrt{Var(\widetilde{CF}_{i,t})}$. We assume that $\widetilde{CF}_{i,t}$ are independent over t and thus can write for the standard deviation of the expected customer lifetime values σ_i :

$$\sigma_i = \sqrt{Var(\widetilde{CLV}_i)} = \sqrt{\sum_{t=0}^T \frac{\sigma_{i,t}^2}{(1+r_f)^{2t}}} = \sqrt{\sum_{t=0}^T \frac{Var(\widetilde{CF}_{i,t})}{(1+r_f)^{2t}}}. \quad (5)$$

- (A4) The portfolio risk σ_{PF} of the expected per capita portfolio return μ_{PF} includes the standard deviations σ_i of all segments I and their covariance Cov_{ij} (cf. e.g., Buhl and Heinrich 2008):

$$\sigma_{PF} = \sqrt{\sum_{i=1}^I \sum_{j=1}^I w_i w_j Cov(\widetilde{CLV}_i, \widetilde{CLV}_j)} = \sqrt{\sum_{i=1}^I \sum_{j=1}^I w_i \sigma_i w_j \sigma_j \rho_{ij}}, \quad (6)$$

whereby $\rho_{ij} \in [0,1]$ denote the Bravais Pearson correlation coefficients that are supposed to be strictly smaller than 1 (correlation between the per capita net cash flows of the customers in segments i are imperfect due to the assumed differences in their exposure to eWOM). The correlation coefficients ρ_{ij} are given in $t = 0$ and constant over the planning horizon T .

Favored objective of a value-based customer portfolio management would be to maximize the expected return while minimize risk (Buhl and Heinrich, 2008; Ryals, 2007). However, as one cannot reach both objectives at the same time, a preference function is necessary. As expected return and risk have to be considered according to the individual risk preference of the decision maker, the preference function has to follow the (μ, σ) -rule. We assume:

- (A5) Every decision maker has a utility function that is compatible with the Bernoulli principle and assigns a utility for all possible values x the random variable \widetilde{CLV}_{PF} can take. Such a utility function is given by $u(x) = 1 - e^{-\alpha x}$. At all times, the decision maker selects the customer portfolio with the highest value of the preference function incorporating the individual level of risk aversion of the decision maker $\alpha > 0$, which can be represented by the Arrow-Pratt measure (Arrow, 1971; Pratt, 1964).

Based on the utility function stated in assumption (A5), we can derive a preference function that integrates return and risk in accordance to the (μ, σ) -rule and is compatible with the Bernoulli-principle (under the constraints of (approximately) normally distributed random

variables \widetilde{CLV}_i and a risk averse decision maker). As the per capita net cash flows $\widetilde{CF}_{i,t}$ are i.i.d. random variables (cf. assumption A2), it may be concluded that the expected per capita customer lifetime value μ_i is (approximately) normally distributed (Buhl and Heinrich, 2008; Hillier and Heebink, 1965). Therefore, we can apply the following preference function (Freund, 1956):

$$\Phi_u(\mu_{PF}, \sigma_{PF}) = \mu_{PF} - \frac{\alpha}{2} \sigma_{PF}^2 = U_{PF} \rightarrow \max! \text{ under the constraints given in Formula (1) (7)}$$

Based on Formula (7), the optimal shares of w_i and thereby an optimal allocation of customers to the different can be determined by applying Markowitz portfolio theory (Markowitz, 1952; 1959).

As discussed before, on the basis of existing empirical results, fans are expected to yield higher cash flows than non-fans, since they are first exposed to a higher volume of eWOM and second particularly exposed to eWOM with positive sentiment. Nevertheless, if the sentiment of eWOM generated on fan pages turns negative, the cash flows of fans are expected to decrease stronger than the cash flows of non-fans. Consequently, the cash flows generated by fans are assumed to be higher but also more risky in comparison to non-fans. Hence, no Pareto efficiency is given and the application of our model is reasonable. However, even if one of the segments (e.g., fans) actually should be Pareto efficient, our model will still provide valid results, thus ensuring practicability. Depending on the outcome regarding the optimal shares of the segments of fans and non-fans, companies face the following levers:

- (1) If the number of fans should be increased, non-fans could be approached or incentivized to become fans (e.g., by (online) marketing campaigns addressing existing or potential customers, who are not fans yet).
- (2) If the number of non-fans should be increased, the customer base could be expanded by acquiring new customers, who are not fans (e.g., by (offline) marketing campaigns addressing potential customers, who are not likely to become fans due to their customer characteristics).

4. Demonstration and Evaluation

In this section, we demonstrate and evaluate the previously introduced model by using a case example based on real-world data from a large online retailer and publicly available data. First, we briefly introduce the online retailer and the data used for our case example. Second, we analyse the ratio between fans and non-fans by applying our model, thereby proofing its utility and validity in business practice. Third, we run a sensitivity analysis to evaluate the robustness of our model. Finally, we concisely discuss our key findings.

4.1. Introduction of the Online Retailer and Data

For demonstrating the applicability of our model in business practice, we draw on data provided by a large online retailer selling predominantly books, DVDs, computer games, and music as well as on publicly available data (cf. Table 2). The online retailer earns double digit million Euro revenues per year and has a very successful fan page on Facebook, which is the retailer's main online marketing channel and the major source of eWOM related to the retailer. For our demonstration and evaluation, we consider data provided by the retailer spanning 18 months and set the planning horizon accordingly. As the retailer wants to remain anonymous, all data has been slightly transformed for publication – however, all results presented in this paper qualitatively conform to the original findings derived from the genuine data set. The focus of the analysis is on the non-fans and fans, who are actual customers and thus enclosed in the underlying data set (see Figure 1). Through their purchase, they became part of the company's customer base and generated revenue data.

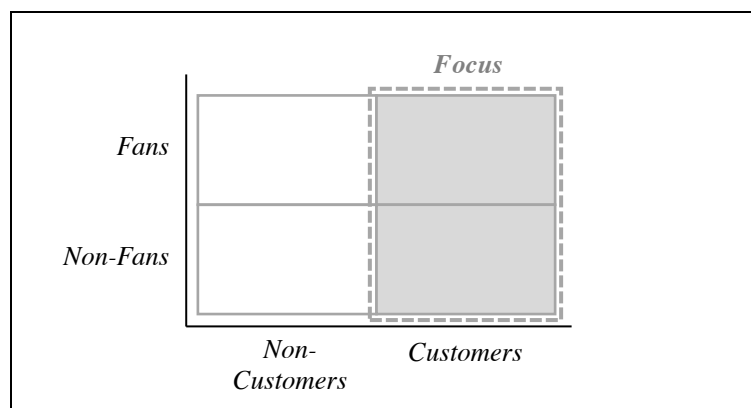


Figure 1: Focus of the analysis

Table 2 summarizes the parameters used for demonstrating and evaluating our model.

Parameter	Definition	Value	Source
T	Planning horizon	18 month	Resulting from data provided by online retailer
$E(\widetilde{CF}_{fans,t})$	Expected per capita cash flows of fans in t	cf. Table 3	Transformed data from online retailer
$E(\widetilde{CF}_{\overline{fans},t})$	Expected per capita cash flows of non-fans in t	cf. Table 3	Transformed data from online retailer
$\sqrt{Var(\widetilde{CF}_{fans,t})}$	Std. dev. of per capita cash flows of fans in t	cf. Table 3	Transformed data from online retailer
$\sqrt{Var(\widetilde{CF}_{\overline{fans},t})}$	Std. dev. of per capita cash flows of non-fans in t	cf. Table 3	Transformed data from online retailer
$\rho_{fans,\overline{fans}}$	Bravais Pearson correlation coefficient	0.355	Calculated based on cash flows (cf. Table 3)
α	Arrow-Pratt measure (level of risk aversion)	0.15	Assessment of the decision maker's individual risk aversion
r_f	Risk-free rate of return per month	0.12%	European Banking Association (Euribor)
$E(\widetilde{sentiment}_t)$	Expected sentiment-score in t	cf. Table 3	Classified data from Facebook's Graph API
$\sqrt{Var(\widetilde{sentiment}_t)}$	Std. dev. of sentiment-score in t	cf. Table 3	Classified data from Facebook's Graph API

Table 2: Definitions, values, and sources for parameters used in case example

Based on the data provided by the online retailer, we were able to derive the average per capita cash flows (calculated by average per capita revenues minus average per capita variable costs) generated by customers who are connected to the retailer's fan page in Facebook (i.e., fans) and customers not connected to its fan page (i.e., non-fans). The two segments of fans and non-fans are denoted by $i = fans, \overline{fans}$ in the following. The approximate shares of 11% fans and 89% non-fans in the retailer's customer base could be determined by an analysis of the online retailers customer base (the actual values for the number of customers N and the customers in the segments n_i can unfortunately not be published due to confidentially reasons).

As the online retailer's planning period (e.g., for forecasting sales) is one month, we calculate both, the expected per capita cash flows of fans $E(\widetilde{CF}_{fans,t})$ and non-fans $E(\widetilde{CF}_{\overline{fans},t})$ as well as the respective standard deviation of the per capita cash flows of fans $\sqrt{Var(\widetilde{CF}_{fans,t})}$ and non-fans $\sqrt{Var(\widetilde{CF}_{\overline{fans},t})}$ on a monthly basis.

Additionally, in order to be able to apply our model in a meaningful way, we also underpin existing findings and assumptions (cf. section 2.2) by downloading 7.619 user-generated wall posts and comments (eWOM) from the online retailer's public Facebook fan page via Facebook's Graph API. After determining the sentiment-score (numeral range from -1 "very negative" to +1 "very positive") of each eWOM via the Free Natural Language Processing Service (loudelement.com, 2014), a free public API for sentiment analysis, we calculate the

expected sentiment-score $E(\widetilde{sentiment}_t)$ as well as the respective standard deviation of the sentiment-score $\sqrt{Var(\widetilde{sentiment}_t)}$. Table 3 depicts both expectations and standard deviations for per capita cash flows of fans, per capita cash flows of non-fans, and sentiment-scores of eWOM on the online retailer's Facebook fan page.

Period t	Fans (11%)		Non-fans (89%)		Sentiment	
	$E(\widetilde{CF}_{fans,t})$	$\sqrt{Var(\widetilde{CF}_{fans,t})}$	$E(\widetilde{CF}_{nonfans,t})$	$\sqrt{Var(\widetilde{CF}_{nonfans,t})}$	$E(\widetilde{sentiment}_t)$	$\sqrt{Var(\widetilde{sentiment}_t)}$
1	5.78 €	1.99 €	4.99 €	1.07 €	0.2889	0.2751
2	5.90 €	2.04 €	5.39 €	1.22 €	0.3442	0.2197
3	5.59 €	1.54 €	4.79 €	1.12 €	0.3047	0.3002
⋮	⋮	⋮	⋮	⋮	⋮	⋮
16	6.05 €	2.16 €	4.97 €	1.23 €	0.3013	0.2674
17	4.98 €	1.14 €	4.74 €	1.15 €	0.2695	0.2889
18	5.91 €	1.75 €	4.93 €	1.06 €	0.3453	0.1794

Table 3: Expected per capita cash flows and standard deviations

In line with existing findings and assumptions (cf. section 2.2), a positive correlation between expected sentiment-scores and cash flows of fans can be ascertained to a 5%-level of significance (cf. Table 4). This means the more positive the eWOM on the online retailers Facebook fan page, the higher the sales of fans. In contrast, the correlation between expected sentiment-scores and non-fans is both lower and not even significant (cf. Table 4). This means that, if at all, the expected sales of non-fans are less influenced by eWOM than expected cash flows of fans. This observation can also be confirmed by looking at the standard deviation of sentiment-scores: while a higher standard deviation of sentiment-scores is negatively correlated with the cash flows of fans to a 10%-level of significance, the correlation between standard deviations of sentiment-scores and cash flows of non-fans is lower and not even significant. This means, a more polarized and heterogeneous eWOM may be, if at all, less relevant to non-fans than fans. Summing up, eWOM significantly influences the cash flows of fans while non-fans are less affected.

	$E(\widetilde{CF}_{fans,t})$	$E(\widetilde{CF}_{nonfans,t})$
$E(\widetilde{sentiment}_t)$	0.523**	0.399
$\sqrt{Var(\widetilde{sentiment}_t)}$	-0.418*	-0.349

* significant at a 10%-level; ** significant at a 5%-level; *** significant at a 1%-level;

Table 4: Correlation between sentiment-scores and cash flows of fans as well non-fans

Furthermore, in line with existing findings and assumptions (cf. section 2.2), the expected per capita cash flows generated by fans (cf. Table 3) apparently exceed the expected per capita cash flows generated by non-fans. This could be confirmed additionally by the paired Student's *t*-test to a 1%-level of significance (Mean: 0.608; Std. dev.: 0.361; Std. error mean: 0.085). If the online retailer was risk neutral, it would fully concentrate on the segment of fans to increase its share to the maximum extent. However, also in line with existing findings and assumptions (cf. section 2.2), the apparently higher standard deviations of the per capita cash flows of fans (cf. Table 3) indicate a higher risk compared to non-fans. This could be confirmed additionally by the paired Student's *t*-test to a 1%-level of significance (Mean: 1.099; Std. dev.: 1.432; Std. error mean: 0.338). Therefore, the retailer's portfolio optimization should not be solely based on the expected per capita cash flows but also incorporate the risk, as proposed in our model (cf. section 2.3).

To finally apply our model, two further parameters are needed: the risk-free discount rate to calculate the expected customer lifetime values of both segments (μ_{fans} and $\mu_{\overline{\text{fans}}}$, cf. Formula 3) and their standard deviations (σ_{fans} and $\sigma_{\overline{\text{fans}}}$, cf. Formula 5) as well as the Arrow-Pratt measure representing the decision maker's level of risk aversion to apply our preference function $\Phi_u(\mu_{PF}, \sigma_{PF})$. To derive the monthly risk-free discount rate r_f , we draw on the average annual Euribor of 1.45% in the relevant time frame of the 18 months considered in our case example (European Banking Federation, 2013). To determine the Arrow-Pratt measure representing the level of the decision maker's risk aversion, one could for example draw on a utility function using related market data (cf. Kasanen and Trigeorgis, 1994). Since $\alpha/2$ could be also interpreted as the price per unit risk (Buhl and Heinrich, 2008), it is also possible to choose that value by assessing the decision maker's (i.e. the online retailer's) individual risk aversion (cf. e.g., Zimmermann et al., 2008), leading to $\alpha = 0.15$. Based on these parameters, we can now analyse the ratio between fans and non-fans and its economic effects.

4.2. Analysis of the Ratio of Fans to Non-Fans

We first calculate the expected per capita customer lifetime values for both segments in $t = 0$ (μ_{fans} and $\mu_{\overline{\text{fans}}}$, cf. Formula 3), the standard deviation of the per capita customer lifetime values for both segments (σ_{fans} and $\sigma_{\overline{\text{fans}}}$, cf. Formula 5), as well as the Bravais Pearson correlation coefficient ($\rho_{\text{fans}, \overline{\text{fans}}}$) based on the data depicted in Table 3. As the correlation coefficient $\rho_{\text{fans}, \overline{\text{fans}}} = 0.355 < 1$, the assumed imperfect correlation (cf. section 2.3) can be affirmed, thus allowing for a diversification effect in our customer portfolio. Table 5 summarizes the resulting values.

Parameter	μ_{fans}	$\mu_{\overline{\text{fans}}}$	σ_{fans}	$\sigma_{\overline{\text{fans}}}$	$\rho_{\text{fans},\overline{\text{fans}}}$
Value	100.10 €	89.29 €	10.94 €	4.78 €	0.355

Table 5: Expected per capita CLV, standard deviations, and correlation

Based on the so far derived parameters, we can now apply our preference function $\Phi_u(\mu_{\text{PF}}, \sigma_{\text{PF}})$ (cf. Formula 7). Given the current allocation of fans ($w_{\text{fans}} = 11\%$) and non-fans ($w_{\overline{\text{fans}}} = 89\%$), the current value of the preference function yields $\Phi_u(\mu_{\text{PF}}, \sigma_{\text{PF}}) = 88.75$.

Maximizing the preference function leads to an optimal share of fans ($w_{\text{fans}}^* = 72\%$) and non-fans ($w_{\overline{\text{fans}}}^* = 28\%$) and a maximum value of the preference function $\Phi_u(\mu_{\text{PF}}, \sigma_{\text{PF}})^* = 91.72$. For comparison, Table 6 summarizes the results for different allocation scenarios including a focus entirely on the segment of fans and non-fans, respectively.

Parameter	Current allocation	Only fans	Only non-fans	Optimal allocation*
w_{fans}	11%	100%	0%	72%
$w_{\overline{\text{fans}}}$	89%	0%	100%	28%
μ_{PF}	90.48 €	100.10 €	89.29 €	97.12 €
σ_{PF}	4.81 €	10.94 €	4.78 €	8.48 €
$\Phi_u(\mu_{\text{PF}}, \sigma_{\text{PF}})$	88.75	91.12	87.58	91.72

Table 6: Results for different allocation scenarios

4.3. Sensitivity Analysis

Using solely historical or forecasted data for calculating the (optimal) portfolio allocation could potentially lead to misleading results: for instance, actual future cash flows could have a higher volatility than the predicted cash flows that were used when optimizing the customer portfolio. In line with previous work (cf. e.g., Zimmermann et al., 2008), we therefore conduct a sensitivity analysis by changing one input parameter ceteris paribus (c.p.) and determining the corresponding optimal customer portfolio.

Thus, we provide insights regarding the robustness of our model and explicate how severely a 10% (c.p.) over- or underestimation of the parameters affects our initial results (cf. Table 5). In Table 6, we state the new expected per capita portfolio return ($\mu_{\text{PF,new}}^*$), the corresponding standard deviation ($\sigma_{\text{PF,new}}^*$), and the optimal portfolio shares ($w_{\text{fans,new}}^*$ and $w_{\overline{\text{fans,new}}}^*$) that would result when optimizing the customer portfolio based on the parameter with a $\pm 10\%$ change (c.p.). Moreover, we compare these results to the expected per capita portfolio return ($\mu_{\text{PF,old}}$) and the corresponding standard deviation ($\sigma_{\text{PF,old}}$) that would result when applying the parameter with a $\pm 10\%$ change to the previously optimized customer portfolio with its old

optimal portfolio shares $w_{\text{fans,old}}^* = 72\%$ and $w_{\text{fans,old}}^* = 28\%$ derived in the preceding section.

Table 7 highlights that the optimal allocation of customers to the segments of fans and non-fans is comparatively robust to variations (c.p.) of the standard deviation of non-fans (σ_{fans}), the Bravais Pearson correlation coefficient ($\rho_{\text{fans},\text{fans}}$), and the level of risk version (α). In contrast, the allocation is sensitive to variations (c.p.) of the expected per capita customer lifetime values of fans and non-fans ($\mu_{\text{fans}}, \mu_{\text{fans}}$). However, it needs to be emphasized that the high sensitivity can be traced back to the fact that both values lie close together ($\mu_{\text{fans}} = 100.10 \text{ €}$, $\mu_{\text{fans}} = 89.29 \text{ €}$). With respect to the standard deviation of the fans' per capita customer lifetime values (σ_{fans}), the model is also sensitive. As rather small estimation errors can consequently lead to rather high deviations from the optimal allocation to the segments of fans and non-fans, the online retailer should especially invest in determining the value for this parameter as precisely as possible.

Parameter	Initial value	-10% +10%	$\mu_{\text{PF,old}}$	$\sigma_{\text{PF,old}}$	$\mu_{\text{PF,new}}^*$	$\sigma_{\text{PF,new}}^*$	$w_{\text{fans,new}}^* / w_{\text{fans,new}}^*$
μ_{fans}	100.10 €	90.09 € 110.11 €	89.87 € 104.36 €	8.48 € 8.48 €	89.37 € 110.11 €	4.79 € 10.94 €	9% / 91% 100% / 0%
μ_{fans}	89.29 €	80.36 € 98.22 €	94.65 € 99.58 €	8.48 € 8.48 €	100.10 € 98.52 €	10.94 € 4.91 €	100% / 0% 16% / 84%
σ_{fans}	10.94 €	9.85 € 12.04 €	97.12 € 97.12 €	7.70 € 9.26 €	99.07 € 95.64 €	9.08 € 7.98 €	90% / 10% 59% / 41%
σ_{fans}	4.78 €	4.30 € 5.25 €	97.12 € 97.12 €	8.41 € 8.54 €	96.91 € 97.33 €	8.25 € 8.71 €	70% / 30% 74% / 26%
$\rho_{\text{fans},\text{fans}}$	0.355	0.3195 0.3905	97.12 € 97.12 €	8.43 € 8.52 €	97.03 € 97.20 €	8.37 € 8.59 €	72% / 28% 73% / 27%
α	0.15	0.135 0.165	97.12 € 97.12 €	8.48 € 8.48 €	97.94 € 96.44 €	9.13 € 7.96 €	80% / 20% 66% / 34%

Table 7: Results for different allocation scenarios

4.4. Discussion

Based on the application of our model and the sensitivity analysis, we discuss three key findings:

- (1) Our proposed model for the analysis of the ratio of fans to non-fans and its economic effects is feasible and leads to reasonable results (“validity”, cf. Gregor and Hevner, 2013). Furthermore, by using a case example based on real-world data provided by a large online retailer and publicly available data, we demonstrate the usability of our model in business practice (“utility”, cf. Hevner et al., 2004). Thus, we successfully proved that the adaption of customer portfolio optimization on the context of fans and non-fans in customer portfolios is reasonable and can be advantageous for companies.
- (2) The case example at hand affirms, as derived from existing literature (cf. section 2.2), that fans have a higher expected customer lifetime value than non-fans (e.g., Rishika et al., 2013) but also bear a higher risk in terms of the respective standard deviation. While a higher expected customer lifetime value is preferable, the associated risk needs to be considered. This is particularly important, as our sensitivity analysis reveals a high influence of the standard deviation of the fans’ per capita customer lifetime values on the optimal customer allocation. Hence, companies should invest in mitigating this risk by preventing eWOM with negative sentiment and its viral spread among fans to potentially reduce the standard deviation of cash flows generated by fans. This could be facilitated by Social Media monitoring and sophisticated detection tools (cf. e.g., Alt and Reinhold, 2012) that allow for intervening at the very beginning when eWOM with negative sentiment is generated.
- (3) Our results suggest – contrary to the popular belief – that keeping a share of customers not connected to a company’s fan page instead of converting all customers to fans can be economically reasonable (even though this segment is more profitable at first sight). Therefore, it is not advisable to attract more fans without questioning the resulting economic effects and interdependencies: “Less could be more!” In the case of the online retailer used for our case example, this implies that the retailer should aim at growing the share of fans from the current level of 11% to 72% but not to a maximum extent. (e.g., by applying lever 1, cf. section 2.3).

5. Conclusion, Limitations, and Outlook

Following the research cycle framework of Meredith et al. (1989), we especially focused on the research stages *description* and *explanation* in a novel way in order to bring together preliminary cross-disciplinary results: first, we reviewed related work regarding the influence of eWOM generated in OSN on the company value in general, on the customer value specifically, and on customer portfolio optimization (cf. section 2.1). By doing so, we aimed at providing the basis for a comprehensive overview and understanding of the problem context and linking the different research streams (*description*). Second, we developed a model based on these research streams, which allows for an analysis of the economic effects of the ratio of fans to non-fans in a company's customer portfolio (cf. section 2.3) taking into account preliminary empirical results of the economic effects of eWOM within customer lifetime value calculations (*explanation*). Third, we conducted an evaluation to assess the model's validity and utility by means of a case example based on real-world data provided by a large online retailer and publicly available data (cf. section 4). Finally, we performed a sensitivity analyses to check the robustness of our model (*testing*) and discussed key findings.

Although our model allows for an analysis of the economic effects of the ratio of fans to non-fans, this paper also implicates assumptions and limitations: first, we did not state and evaluate the relationship between eWOM and per capita net cash flows explicitly within the scope of this paper. As numerous existing research already demonstrated the relationship between economic measures and eWOM generated in OSN (cf. Table 1), we abstracted by assuming this interrelation. However, we successfully tested and confirmed this assumption to allow for a meaningful application of the model. A further in-depth investigation applying our model within (empirical) research should be conducted in future research following the idea of Meredith et al. (1989) of an ongoing research cycle. Second, we focused on two segments (fans and non-fans), hence not necessarily reflecting the complete reality. However, we state the model in a general form, thus making it easy to incorporate more customer segments (e.g. a finer grained segmentation based on other customer characteristics) in further, consecutive research. Third, potential adjustments to the existing customer portfolio that are necessary after the portfolio optimization (e.g., acquisition of further non-fans) can be costly and raise strategic issues beyond the scope of this paper (this is in line with prior work on customer portfolio optimization, such as Tarasi et al., 2011). Therefore, “[t]he optimal [customer] portfolio can best be viewed as an ideal customer base that managers can evaluate, revise, and assemble over time” (Tarasi et al., 2011, p. 4).

Even though these limitations leave room for future research, the paper at hand is a practically feasible step towards a value-based customer portfolio management with respect to the promotion of fan pages in OSN and the resulting number of fans in a company's customer portfolio: many companies host fan pages and approach and incentivize (potential) customers to become fans in order to leverage the considerable economic influence of eWOM generated in OSN. However, even though the sentiment of eWOM is prevalently positive, a sheer maximization of the share of fans in a customer portfolio must be critically reflected: while fans yield higher expected cash flows than non-fans, also the associated risks in terms of these cash flows' volatility might be considerably higher. Thus, diversifying this risk by keeping a share of non-fans – or even increasing it – might be economically reasonable. By suggesting a model for the analysis for the economic effects of the ratio of fans to non-fans in a company's customer portfolio, this paper contributes to bridging the gap between research on economic effects of eWOM generated and disseminated within OSN and customer portfolio optimization in the context of an ongoing research cycle. Thus we provide the basis for model extensions as well as hypothesis generation and testing in the course of further iterations entirely within the meaning of Meredith et al. (1989).

6. References

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IV. Performance Measures Relating to Sustainability

Research Paper 4: “Towards Corporate Sustainability: are Sustainability Performance Targets tied to Executive Compensation? Empirical Insights Based on Publicly Traded Corporations”

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Abstract: Successfully implementing corporate sustainability strategies became a focal point in research and practice. A challenge is to ensure that defined social, environmental and (long-term) economic performance targets are pursued properly. The purpose of this study is to investigate whether sustainability performance targets are tied to executive compensation as means to foster corporate sustainability implementation. Therefore, the paper presents a content analysis of the annual reports and proxy statements of 60 publicly traded companies of the DJIA and the DAX. First, the specific sustainability targets are examined qualitatively based on a comparison of the years of 2009 and 2012 along with their general disclosure quality. Second, the results are discussed against the backdrop of the corporations' conformity with leading sustainability guidelines. The results show that the investigated corporations use sustainability targets only hesitantly within executive compensation contracts. Especially environmental targets find poor consideration. The clear compensation incentive focus lies on economic targets. The disclosed information about the specific targets, such as their precise definition or concrete target levels, lacks granularity and transparency. While the corporations' conformity to leading sustainability guidelines or standards plays an important role in corporate governance in general, it is not an indicator for the consideration of sustainability targets in further governance mechanisms, such as in executive compensation. In summary, the study reveals that executive compensation is not fully leveraged to foster corporate sustainability.

1. Introduction

The demand for corporations to be managed according to environmental and social responsible as well as sustainable business principles has increasingly established within our modern society. Besides customers, employees or (non-)governmental organizations (see Collins et al., 2007; Kiron et al., 2012; Windolph, 2013), in recent years also investors have exceedingly attached importance to sustainable business practices instead of to mere financial aspects (Borghesi et al., 2014; Cooperman, 2013; Girerd-Potin et al., 2014; Maon et al., 2009; Merriman and Sen, 2012). Among other reasons, investors recognize enormous risk management and long-term performance potential for their portfolios (GSIA, 2013). As a result, the so-called socially responsible and sustainable investing (SRI) movement emerged, where investors incorporate environmental, social, and corporate governance (ESG) criteria into their investment decisions (European Sustainable Investment Forum (Eurosif) 2012; Martin, 2008; Sandberg et al., 2009). The high relevance of SRI is reflected by the \$13.6 trillion SRI assets under management worldwide, which accounts for a market share of 21.8 % of all assets (GSIA, 2013). The Forum for Sustainable and Responsible Investment in the United States (US SIF) even states that “[...] today, more than one out of every nine dollars under professional management in the United States is invested according to strategies of sustainable and responsible investing” (US SIF, 2012).

Consequently, sustainable investors are bent on the successful implementation of corresponding sustainability strategies. Thereby, particular executives play a crucial role (Lindgreen et al., 2011), as they need to steer corporate activities in line with predefined sustainability performance targets. Numerous research studies show that the target system of shareholders can be effectively aligned with those of executives by means of performance-related compensation contracts (see e.g. David et al., 1998; Deckop et al., 2006; Gregory-Smith et al., 2009; Jensen and Murphy, 2010; Nyberg et al., 2010; Ozkan, 2009; Sigler, 2011). Accordingly, the executive compensation contracts ought to reflect also predefined sustainability measures to encourage executives to manage corporate activities in line with particular sustainability strategies. However, although the topic of linking sustainability measures with executive compensation is increasingly on the investors’ agenda (Berrone and Gomez-Meija, 2009b) as well as on that of formal regulations or guidelines (GRI, 2011; UN Global Compact, 2014; Waddock, 2008), empirical research is still in its infancy. Hence, the field lacks an overview for both, research and practice, on the current procedures, which might provide the basis to evaluate and compile potential advancements. This paper therefore investigates the following research questions (RQ):

- RQ1. To what extent are sustainability targets of the environmental, social or (long-term) economic dimension considered within executive compensation contracts?
- RQ2. What is the disclosure quality of sustainability targets tied to executive compensation?
- RQ3. Does the corporations' conformity with the leading sustainability guidelines translate into executive compensation in form of a link with sustainability targets?

To answer these research questions, a content analysis was conducted based on the annual reports and proxy statements of 60 publicly traded companies listed on the US Dow Jones Industrial Average Index (DJIA) for the Anglo-American sphere, as well as on the German Stock Index (DAX) for the Central European sphere, which are the most progressive SRI markets (GSIA, 2012). The analysis compares the results for each research question for the DJIA and DAX corporations based on the years 2009 and 2012, respectively. Overall, by this means the paper aims at depicting the progress in considering sustainability targets within executive compensation contracts and thus responding to the call “[...] *research should examine the extent to which ‘triple bottom line’ criteria are reflected in executive compensation*” (McGuire et al., 2003, p. 356), claimed also by Thannisch (2011). The triple bottom line concept refers to the consideration of the environmental, social and economic sustainability dimensions in an integrated manner (Elkington, 2004). The results of this work, namely the extensive discussion of the specific sustainability targets linked to compensation contracts shall also contribute to the current theoretical discussion about the progress of the sustainability implementation within corporations (Collins et al., 2007; Klettner et al., 2013; Lindgreen et al., 2011). Furthermore, this shall stipulate the interdisciplinary discourse between compensation and sustainability research (Klettner et al., 2013) as basis for further (empirical) investigations and theory development. This might also foster the adaption of according laws and regulations, a major driver of trends in executive compensation (Murphy, 2012).

The remainder of this paper is structured as follows: first, it presents foundations on corporate sustainability as well as on performance-related executive compensation. In the subsequent section, a description of the study design and the presentation of the results of the content analysis follow. Further, the empirical findings as well as both, theoretical and practical implications are being discussed.

2. Corporate Sustainability and the Increasing Pressure by Investors

Over decades, there has been an ongoing debate on the social and environmental obligations of corporations, initiating a paradigm change in the business sphere. Thereby, the concept of *corporate sustainability* evolved. While some authors use the term interchangeably with corporate social responsibility (CSR), corporate responsibility or corporate citizenship, others differ slightly in their definitions depending on the applied context or discipline (for a review see e.g. Dahlsrud, 2008) so that no universally valid definition crystallized (Freeman and Hasnaoui, 2011). Nonetheless, there is broad consensus on the concept's fundamentals. Certainly one of the cornerstones was the renowned definition by the Brundtland Commission: in the report "Our Common Future", it formulated sustainability as a "[...] development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Conference on Environment and Development (WECD), 1987). More and more, the role of business is deemed crucial for a successful sustainable development and so in 1997, Elkington created the seminal "triple bottom line" concept. He postulates that corporations should integrate sustainability principles in their core business activities and strive not only for economic value, but also for environmental and social values in an integrated manner (Elkington, 1997). Furthermore, he outlines different external pressure waves that led corporations to shift their focus in this context from mere compliance to competitive and corporate governance issues, which advanced the triple bottom line agenda "from factory fence to boardroom" (Elkington, 2004). External pressure faced by corporations regarding sustainable business practices is predominantly attributed to its stakeholders and thus associated research builds on stakeholder theory to explain their weight (Campbell, 2007). Freeman (1984, p. 25) broadly defined stakeholder as "[...] any group or individual who can affect or be affected by the achievements of an organization's objectives". In addition, Clarkson (1995) further distinguishes primary stakeholders (e.g. employees, customers, or stockholders) that are vital for a corporation's business and thus very powerful in their claims, and secondary stakeholders (e.g. communities, or media) with influential power on the primary stakeholders. Therefore, it is very important for a corporation to create value for its stakeholders and to respond to their different expectations (Collins et al., 2007; Orlitzky et al., 2011) among which the demand for sustainable business practices has firmly established by now. In essence, corporate sustainability evolved into a business policy that aligns environmental, social and economic aspects within the core operational activities to account for the interests of different stakeholder groups.

In recent years, a particularly powerful stakeholder group entered the limelight in research and practice: due to several reasons, investors have exceedingly attached importance to sustainable business practices instead of to mere financial aspects (Borghesi et al., 2014; Cooperman, 2013; Girerd-Potin et al., 2014; Maon et al., 2009; Merriman and Sen, 2012). There are both, internal forces, i.e. the specific motivation of an institution or company, as well as external forces, i.e. regulations or institutional standards, that drive investors to engage in corporate sustainability (Sievänen et al., 2013). On the investor-individual level, the prevailing motivations are attributed to their expectations for good financial performance, risk-return trade-offs and the potential for portfolio diversification, as well as moral considerations (GSIA, 2013; Sandberg et al., 2009; Sievänen et al., 2013). Externally, several initiatives pushed a rethinking in the mainstream investment markets: particular important was the 2004 UN Global Compact Leaders' Summit, hosted by UN Secretary General Kofi Annan, where twenty investment companies from nine countries participated. It gave birth to the "Who Cares Wins" initiative that – in partnership with International Finance Corporation (IFC), the Government of Switzerland, and the UN Environment Programme's (UNEP) Finance Initiative – aimed "[...] to increase the industry's understanding of the risks and opportunities presented by environmental, social and governance (ESG) issues, and to improve their consideration in investment decision-making" (Knoepfel and Hagart, 2009). This provided also the basis for a further important landmark for the value change in the investment sphere: in 2006, the UN Global Compact in cooperation with the UNEP Finance Initiative launched the Principles for Responsible Investment (PRI). This initiative, with today more than 1200 institutional investors that represent more than \$34 trillion in assets, aims at fostering its signatories in implementing six principles for the incorporation of ESG criteria in investment decisions and ownership practices (UN PRI 2014). In the course of this, a socially responsible and sustainable investing (SRI) movement emerged with \$13.6 trillion SRI assets under management worldwide, which accounts for a market share of 21.8 % of all assets (GSIA, 2013). These huge SRI volumes are, of course, also associated with corresponding high expectations: if investors integrate sustainability criteria into their investment decisions, they demand of the corporations they have invested in, to proceed successful sustainability strategies.

3. Performance-related Executive Compensation and the Implementation of Corporate Sustainability

Although sustainability has thus firmly established on the top managements' agendas (Accenture and UN Global Compact, 2013; Kiron et al., 2012), its successful implementation remains challenging and implicates many yet unresolved issues (Lindgreen et al., 2011; Klettner et al., 2014; Spitzeck, 2009; Yuan et al., 2011). An effective implementation and integration requires multi-dimensional decision-making and trade-off assessments, and it should ideally result in a mutually beneficial, i.e. win-win, setting for the corporation and its environment (Elkington, 1994). According to Elkington, “[...] *the challenges of integration will increasingly play out in [the] four key areas [...] balance sheets (transparency, accountability, reporting and assurance), boards (ultimate accountability, corporate governance and strategy), brands (engaging investors, customers and consumers directly in sustainability issues) and business models (moving beyond corporate hearts and minds to the very DNA of business)*” (2004). Thereof, it is increasingly given weight to the role of the board, top executives and governance structures for transforming business operations towards sustainability (Lindgreen et al., 2011; Spitzeck, 2009). Especially, the design of the executive compensation packages is being highlighted as the missing link to fuse sustainability with core business activities (Berrone and Gomez-Mejia, 2009a; Klettner et al., 2014; Lindgreen et al., 2011).

Researchers – especially in the field of corporate governance – prevalingly quote (positive) principle-agency theory as explanation for the above mentioned, anticipated incentive effect of performance-related executive compensation (Daily et al., 2003; Deckop et al., 2006; Devers et al., 2007). Based on the seminal work of Jensen and Meckling (1979), it is argued that the interests of shareholders (principle) and executives (agent) can be aligned, if the agent is being incentivized in terms of particular governance mechanisms to act in the benefits of the principle rather than in mere self-interest. One of the dominant governance mechanisms serving that purpose are performance-related compensation contracts, where the executive compensation is tied to particular performance targets fostering a corporation's strategic agenda (van Essen et al., 2012). In fact, Devers et al. reason that “[...] *rather than dispatching executives' self-interest, incentive pay is intended to take advantage of executives' self-interest by channeling their focus away from extracting opportunistic rents and toward maximizing shareholder wealth. More specifically, by linking compensation to firm performance, incentive pay is intended to motivate executives to focus on shareholder value-maximizing, rather than shareholder value-detracting but personal value-increasing actions (e.g., shirking, excessive*

perquisite consumption)” (2007, p. 1026). An extensive overview and structure of the research on the influence of corporate performance on pay and vice versa as well as the influence of pay on executive actions and vice versa, which is not the scope of this paper, is presented by Gomez-Mejia and Wiseman (1997) and the follow-up study by Devers et al. (2007).

4. Research Gap

Although previous research extensively investigated the relationship between performance-related compensation and certain financial and even non-financial measures (see e.g. see e.g. Deckop et al., 2006; Devers et al., 2007; Jensen and Murphy, 2010; Ozkan 2009; Sigler 2011), empirical research with respect to its linkage to sustainability is still in its infancy.

McGuire et al. (2003) and Deckop et al. (2006) investigate the relationship between different CEO compensation components and corporate social performance, which is regarded as the performance expectations of a range of stakeholders. Mackenzie (2007) analyses the role of boards and installed incentive schemes in corporations for not complying with CSR standards. Berrone and Gomez-Mejia (2009b) discuss challenges that occur with the integration of social criteria within managerial incentive schemes along with possible solutions. Thannisch (2011) discusses trends in executive pay against the backdrop of political developments in Germany. By means of an experimental manipulation of direct and indirect pay incentives for an environmental sustainability project as well as a production cost savings project, Merriman and Sen (2012) investigate how pay composition affects the sustainability engagement of middle management. These academic works are supplemented by some practical studies, such as “Greening the Green”, conducted by the proxy advisory company Glass, Lewis & Co., which contains statistical evidence on the link between executive pay and sustainability of publicly traded corporations. Hence, this research shall contribute to the existing knowledge by depicting qualitatively the status quo of sustainability targets within compensation contracts by analyzing and comparing all three dimensions simultaneously over the course of three years after the financial crisis.

5. Study Design

This paper is based on a content analysis of the annual reports and proxy statements of 60 publicly traded companies listed on the leading US Dow Jones Industrial Average Index (DJIA) as well as on the German Stock Index (DAX) (as released at January 2014). The rationale is that the United States, representing the Anglo-American sphere, and Germany, representing the Central European sphere, are the most progressive SRI markets (GSIA, 2012). By drawing on the respective leading indices, the analysis spans various industries and potential sustainability

leaders and laggards. In addition to the international comparison, this paper aims at depicting the development of compensation design over time. In the course of the analysis, the years of 2009 and 2012, respectively are being contrasted, beginning with the aftermath of the financial crisis which might have boosted a change of thinking.

For the base sample, each executive compensation package as listed in the corporations' annual reports or proxy statements was decompounded. First, the respective sections that disclose the compensation components were searched for targets that relate to an environmental, social or economic sustainability dimension. Thereby, only the core executive compensation components were considered, i.e. excluding supplemental benefits. Second, the extracted targets were categorized to these dimension by drawing on leading sustainability guidelines or ratings for validation, such as GRI, UN Global Compact or Sustainalytics, a global responsible investment research firm specialized in ESG research and analysis (2014). Regarding economic performance targets, this paper distinguishes different performance periods: short-term (i.e. one-year-period), mid-term (i.e. two to three-year-period), and long-term (i.e. more than three-year-period). These time bounds are in line with current compensation design practices (see e.g. Allianz, 2012; Walt Disney, 2012) and the fact, that the long-term time frame considers the median tenure of a CEO with about 4,5 years (Gregory-Smith et al., 2009). Accordingly, only long-term oriented economic targets promote positive social performance (Deckop et al., 2006) and hence reflect the long-term oriented economic sustainability dimension. Furthermore, the labels of the observed individual performance targets were unified and condensed to subject-specific target groups, were applicable, for reasons of clarity and comprehensibility. This is reasonable, since many of targets applied by the different corporations have a similar purpose and only a diverse denomination. The prevalingly used target labels were set as labels of the comprising groups. Thereby, the listed targets were assigned to the different groups by strictly following the official performance target definition in the compensation clarification of the respective corporation's report or proxy statement. No further personal interpretations such as of other text passages beyond the remuneration section have been conducted in order to not adulterate the results. To verify the results, the outlined process was conducted with dual control.

The scope of this paper is not to discuss the executive compensation mix in principle, such as the optimal proportion of single components, or the incentive impact or pay-performance sensitivity of different components (see e.g. Devers et al., 2007; Murphy, 2012). The study focuses on a qualitative analysis of the sustainability targets considered within compensation contracts.

6. Analysis

6.1. Qualitative Analysis of the Sustainability Performance Targets (RQ1)

First, this section presents an overview on how many corporations consider the three sustainability dimensions within the examined compensation contracts, respectively. This highlights on which of the environmental, social and economic aspects corporations put the most emphasis.

In 2009, as figure 1 and 2 show, executive compensation was clearly designed to promote *economic* performance targets. *Environmental* performance targets, on the contrast, were almost non-existent, as they can be found only in one DJIA corporation's compensation contract. *Social* performance targets were represented slightly stronger, namely in 17 (i.e. 57 %) of the DJIA but only in 4 (i.e. 13 %) of the DAX corporations. Sustainability has found its way into the compensation contracts mainly by a *long-term* adaption of traditional accounting and non-financial targets (indirect driver of economic success) within 28 (i.e. 93 %) of the DJIA and 19 (i.e. 63 %) of the DAX compensation contracts. Within the DJIA corporations, this is almost even with the proportion of short- (100 %) and mid-term (93 %) economic targets, whereas in the DAX corporations the focus lies more on short- (93 %) than on mid-term (53 %) economic targets. Taken together, in 2009 the environmental and the social dimension found little consideration in executive compensation design and further, the corporations of the DJIA were in a leading role in linking compensation to sustainability targets.

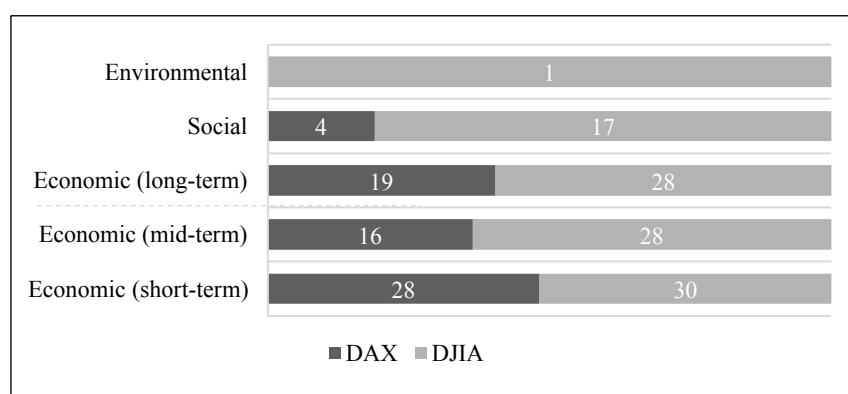


Figure 1: Number of Corporations Using Respective Targets (2009)

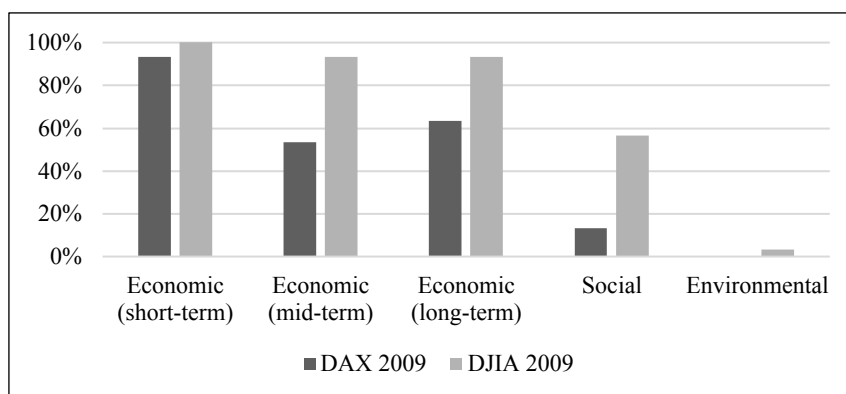


Figure 2: Target Weight of DAX and DJIA Corporations (2009)

From 2009 to 2012, there was a shift in progress. In 2012, as Figure 3 and 4 demonstrate, the DJIA and DAX corporations assimilated in their concentration on the different target dimensions. Executive compensation packages have been linked increasingly to *environmental and social performance* targets. More compensation contracts comprised *environmental* performance targets, with 4 in the DAX (i.e. an increase from 3 % to 13 %) as well as 4 in the DJIA (i.e. an increase from 0 % to 13 %). Nevertheless, this was still the least represented dimension. With respect to *social* performance targets, the DAX corporations caught up and hence in 2012, 11 of the DAX (i.e. an increase from 13 % to 37 %) and 18 of the DJIA (i.e. an increase from 57 % to 60 %) corporations integrated them in their compensation contracts. They also equalized regarding the *long-term orientation of economic* performance targets with a number of 24 DAX corporations (i.e. an increase from 63 % to 80 %). Almost unaltered, 27 (i.e. 90 %) of the DJIA compensation contracts were linked with long-term performance targets. For the traditional short-term economic performance targets with 28 DAX or 30 DJIA corporations as well as the mid-term economic performance targets with 24 DAX or 29 DJIA corporations, no significant changes were observable. In summary, the relevance of the sustainability dimensions within the executives' compensation contracts increased and the focus of the DAX and the DJIA corporations almost equalized. The sharp increase of the additional focus of DAX corporations on sustainability is certainly driven by the implementation of 2009 Act on the Appropriateness of Management Board Remuneration (Thannisch, 2011). Still, overall the major incentive orientation is towards economic performance targets: they are linked with the respective compensation components twice as much as social targets or even three times as much as environmental targets.

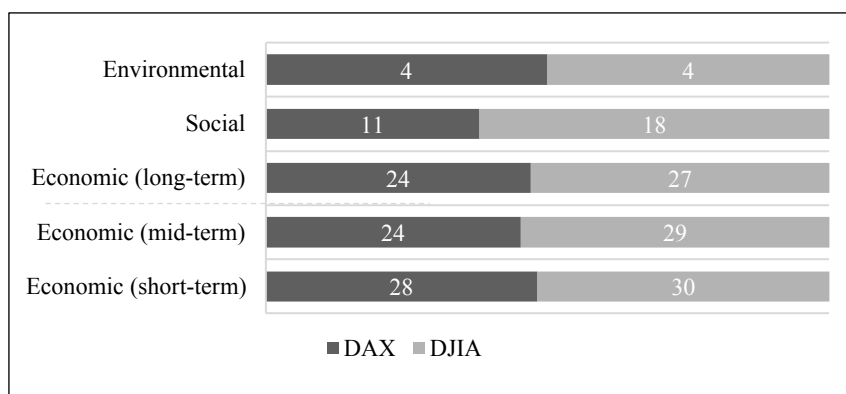


Figure 3: Number of Corporations Using Respective Targets (2012)

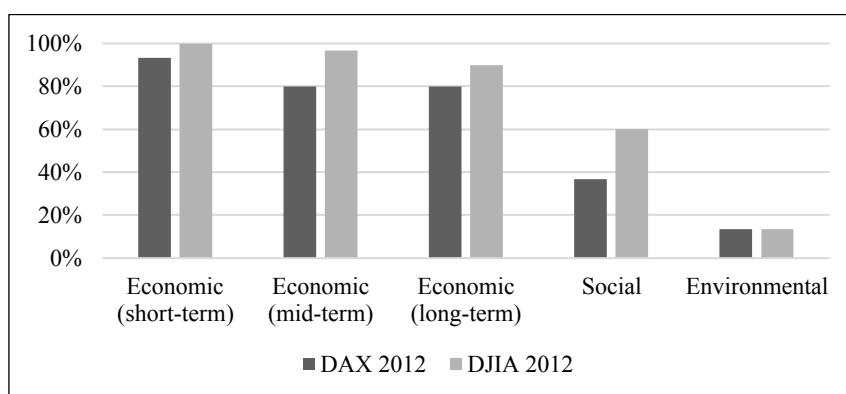


Figure 4: Target Proportion of DAX and DJIA Companies (2012)

Social and Environmental Sustainability Targets

This section presents a qualitative analysis of the social and environmental performance targets tied to compensation components. The discussion starts with a detailed presentation of the specific, applied targets. Then, it examines in detail the frequency of their implementation within (1) the DJIA and (2) the DAX contracts of the years 2009 and 2012, respectively. Finally, it contrasts the results by means of an comparison of the DJIA and the DAX.

Introduction of the Specific Applied Targets

First, the targets of the *social dimension* that were found in both, the DJIA and the DAX executive compensation packages could be grouped as (see table 1 and 2): *Employee Satisfaction or Motivation*, *Diversity* and *Social Responsibility*. Further, the DJIA corporations contained *Safety*, *Health*, and *Teamwork* whereas the focus of the DAX corporations lied on *Compliance* and *Responsible, Attractive Employer*. Employee Satisfaction or Motivation also refers to the implementation or improvement of proper employee development, promotion and training opportunities. Merck (2009, p. 35) for instance, defined the target as “building and retaining the talent to win”. The category also includes the incentive to boost the employees’ engagement level (such as Pfizer, 2009). The rationale is that these targets influence in turn the

employees' satisfaction or motivation. Prevailingly, these targets were not further explicated within the compensation reports. Diversity aims at creating a workplace with equal opportunities for every employee and specifically promoting certain minority groups. Whereas the majority did not outline their diversity goals, some defined it more precisely as age, gender or ethnic diversity (such as BMW, 2012). Social Responsibility subsumes all targets in the compensation contracts that foster a responsible and protective role of the respective corporation on a general level or towards the society as a whole. For instance, the compensation contracts of the Daimler Group's executives were tied to a "[...] deepened establishment [...] of the principles of the UN Global Compact [in the corporation]" (2012, p. 120). Johnson & Johnson incentivized their executives to support health care improvement programs on political and philanthropic level (2009, p. 20 ff.). Others simply listed that target in the compensation contracts without further precise objectives under terms such as corporate citizenship (Microsoft, 2012, p. 40), or sustainable development and social tasks (Munich RE, 2012, p. 50). Safety tied to compensation shall urge executives to ensure a safe workplace or manufacturing processes (Caterpillar, 2009) and thus to achieve a reduction of work injuries or fatalities (Chevron, 2012, p. 31). Health refers to supporting the employees' personal well-being, which meant for Walt Disney a "[...] promotion of a long-term health-care strategy designed to improve services, promote health and wellness and lower growth in costs" (2012, p. 34). Johnson & Johnson installed Health within the executives targets to "[...] keep employee healthcare spending below industry trends and strengthen employee health with targeted interventions for high risk employees supported with wellness and prevention programs at all major locations" (2012, p. 40). The remaining corporations did not further elaborate on that goal. Teamwork, in this case, refers explicitly to the collaboration among top executives in achieving the corporate goals and living up to their role model function. JP Morgan, for instance, stated that "an emphasis on teamwork and a 'shared success' culture should be encouraged and rewarded" (2012, p. 59). Compliance aims at steering business operations in conformity with legal regulations, defined internal and external guidelines as well as without corruption. The target to be a Responsible, Attractive Employer was stated by some corporations without further specification. For that reason, it is interpreted in line with more detailed target definitions: it fosters the creation of a social responsible workplace that meets the needs of its employees with regard to health, work conditions and safety.

Second, in terms of the *environmental dimension*, the executive compensation packages of the DJIA and the DAX corporations (see table 1 and 2) were prevailingly tied to Environment

Protection in general without further details. In addition to that, the compensation contracts of DAX corporations designated Emission Control for climate protection as environmental target.

Analysis of the DJIA

With respect to the DJIA (see table 1), in 2009 the most frequently applied targets within the underlying executive compensation contracts were Diversity (11 contracts) and Employee Satisfaction or Motivation (9 contracts). Hence, around 50 % of the corporations with social performance targets installed these targets in their incentive schemes. Furthermore, 24 % focused on Teamwork on executive level, in fact all of them except one corporation as their only social target. The remaining social targets found only little consideration (Health, Social Responsibility in 2 contracts, Safety in 3 contracts). In 2012, although the total number of contracts with social targets was almost the same, the focus shifted slightly and split up more equally between the different targets. Still, Diversity was the most prominent target (9 contracts, among which 50 % were the same corporations as in 2009) still accounting for 50 % of the corporations with social performance targets. Employee Satisfaction or Motivation found less consideration (6 contracts), whereas Health (4 contracts) and Social Responsibility (3 contracts) were applied in additional contracts compared to 2009. Teamwork remained unaltered (4 contracts) and one corporation dropped Safety (2 contracts). Despite these changes in the course of time, on average per target 70 % of the corporations remained the same in 2012 compared to 2009.

The environmental dimension found notably less consideration. Thus, in 2009 only one corporation tied it to its executive compensation by means of Environmental Protection and in 2012 three additional corporations followed (4 contracts in total).

Targets of the Social and Environmental Dimension	Social												Environment Protection		
	Employee Satisfaction / Motivation		Diversity		Social Responsibility		Safety		Health		Teamwork				
	2009 2012	2009	2012	2009	2012	2009	2012	2009	2012	2009	2012	2009	2012	2009	2012
3M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
American Express	○	●	○	●	-	-	-	-	-	-	-	-	-	-	-
AT&T	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Boeing	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Caterpillar	-	-	○	-	-	-	○	-	-	-	-	-	-	-	-
Chevron	-	-	○	-	-	-	○	●	-	●	-	-	-	-	●
Cisco Systems	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coca-Cola	-	-	○	-	○	●	-	-	-	-	-	-	-	-	●
E.I. du Pont Nemours	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Exxon Mobile	-	-	-	-	-	-	○	●	○	●	-	-	○	●	-
General Electric	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Goldman Sachs	-	-	-	●	-	-	-	-	-	-	-	-	-	-	-
Home Depot	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Intel	-	●	-	●	-	-	-	-	-	-	-	-	-	-	●
IBM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Johnson&Johnson	○	●	○	●	○	●	-	-	-	●	-	-	-	-	-
JP Morgan	-	-	-	-	-	-	-	-	-	-	○	●	-	-	-
McDonald's	○	●	-	-	-	-	-	-	○	-	-	-	-	-	-
Merck & Co	○	●	○	-	-	-	-	-	-	-	-	-	-	-	-
Microsoft	-	-	-	●	-	●	-	-	-	-	-	-	-	-	-
Nike	-	-	-	-	-	-	-	-	-	-	○	●	-	-	-
Pfizer	○	-	○	-	-	-	-	-	-	-	-	-	-	-	-
Procter&Gamble	-	-	○	●	-	-	-	-	-	-	-	-	-	-	-
Travelers Companies	-	-	-	-	-	-	-	-	-	-	○	●	-	-	-
United Technologies	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
United Health	○	●	-	-	-	-	-	-	-	-	○	●	-	-	-
Verizon	○	-	○	●	-	-	-	-	-	-	-	-	-	-	-
Visa	○	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Walmart	-	-	○	●	-	-	-	-	-	-	-	-	-	-	-
Walt Disney	○	-	○	●	-	-	-	-	-	●	-	-	-	-	-
	9	6	11	9	2	3	3	2	2	4	4	4	1	4	

Table 1: Summary of Social and Environmental Targets Tied to Compensation (DJIA)

Analysis of the DAX

In the DAX executive compensation packages, social targets were implemented only sporadic in 2009 (see table 2). The applied targets were Employee Satisfaction or Motivation (2 contracts), Compliance (2 contracts) and Responsible, Attractive Employer (1 contract). The picture changed significantly for the year 2012, certainly driven by the implementation of 2009 Act on the Appropriateness of Management Board Remuneration (Thannisch, 2011). Not only the total number of compensation contracts tied to social targets increased from 4 to 17 (as discussed above), but also the focus on the definite targets. Thus, 82 % of the corporations with social targets by then installed Employee Satisfaction or Motivation (9 contracts), followed by 45 % with Social Responsibility (5 contracts). The latter has not yet been applied within compensation contracts in 2009. The remaining social targets were Diversity (3 contracts), also not applied in 2009, Responsible, Attractive Employer (3 contracts), and Compliance (1 contract). As this dimension only recently attracted the attention within the DAX, no evidence

can be provided at this point on the stability of the precise applied targets within the respective corporations.

In 2009, none of the DAX executive compensation packages was tied to environmental performance targets. In 2012, however, the environmental dimension found its entry – although still timidly – into the compensation contracts, namely with Environment Protection (3 contracts) and Emission control (2 contracts).

Targets of the Social and Environmental Dimension	Social										Environmental				
	Employee Satisfaction and Motivation		Diversity		Social Responsibility		Compliance		Responsible Attractive Employer		Environment Protection		Emission Control		
	2009 / 2012	2009	2012	2009	2012	2009	2012	2009	2012	2009	2012	2009	2012	2009	2012
Adidas	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Allianz	-	●	-	-	-	●	-	-	-	-	-	-	-	-	-
BASF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BAYER	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Beiersdorf	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BMW	-	●	-	●	-	●	-	-	-	●	-	-	-	-	●
Commerzbank	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Continental	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Daimler	-	-	-	-	-	●	○	●	-	-	-	●	-	-	-
Deutsche Bank	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Deutsche Boerse	-	-	-	-	-	-	-	-	○	-	-	-	-	-	-
Deutsche Lufthansa	-	●	-	-	-	-	-	-	-	-	-	●	-	-	-
Deutsche Post	-	●	-	-	-	-	-	-	-	-	-	-	-	-	-
Deutsche Telekom	-	●	-	-	-	-	-	-	-	-	-	-	-	-	-
E.ON	-	-	-	●	-	-	-	-	-	-	-	-	-	-	-
Fresenius Medical Care	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fresenius	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HeidelbergCement	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Henkel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Infineon Technologies	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
K+S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LANXESS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Linde	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Merck	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Munich RE	-	●	-	●	-	●	-	-	-	-	-	-	-	-	-
RWE	-	●	-	-	-	●	-	-	-	●	-	●	-	-	●
SAP	-	●	-	-	-	-	-	-	-	●	-	-	-	-	-
Siemens	○	-	-	-	-	-	○	-	-	-	-	-	-	-	-
ThyssenKrupp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
VW	○	●	-	-	-	-	-	-	-	-	-	-	-	-	-
	2	9	-	3	-	5	2	1	1	3	-	3	-	-	2

Table 2: Summary of Targets Tied to Compensation (DAX)

Summary and Comparison

In summary, in 2009 the DJIA executive compensation contracts were tied much stronger to the social sustainability dimension than those of the DAX. This holds true both for the number of corporations with contracts containing social targets as well as the range of the concrete applied targets. The situation for the environmental dimension in the DJIA and DAX was likewise weak, as almost no contract was tied to environmental targets. However, until 2012 the situation has changed significantly. On the one hand, the number of DAX corporations with

contracts tied to social targets grew and on the other hand, the range of applied social targets broadened in general. Regarding the tie to environmental targets, the number of contracts has increased both, in the DJIA and the DAX. In terms of the most frequently applied sustainability targets, Employee Satisfaction or Motivation (within the DJIA and the DAX) and Diversity (DJIA) stand out. The rationale why corporations foster these targets seems obvious: a pool of broadly skilled, satisfied and thus motivated employees means valuable human and social capital to corporations. That is vital to successful business operations and may form or sustain a competitive advantage. Furthermore, diversity has been a huge issue in public and political discussions in recent years resulting in immense social pressure for corporations, especially in the U.S. multicultural society. Hence, one could argue that the discussed corporations have their strong focus on those targets not merely as an end unto themselves. It is also a respond to societal pressures as Cole and Salimath state “[...] incorporating diversity in an organization’s identity reflects the adoption of a favorable societal value” (2013, p. 152). It also forms a healthy social environment, which in turn positively influences firm performance and successful strategy implementation (Buller and McEvoy, 2012). The results showed also that regional social issues influence the compensation design: only the DJIA contracts were tied to the targets Health Care and Safe Workplace, whereas the DAX contracts fostered the targets Compliance and Responsible & Attractive Employer. That seems explicable against the backdrop of the insufficient health care coverage of U.S. citizens, while Germany struggled with compliance scandals due to revealed cases of corruption. The further results are not distinct enough and do not allow for absolute conclusions as the executive compensation design is also influenced by the individual corporate culture and specific goals.

Overall, this demonstrates a general increase of social and environmental performance targets in executive compensation contracts. That is in line with corporations striving to implement and “live” the guidelines they postulate, such as the UN Global Compact, within their business operations. Not only the number of contracts with a direct tie to sustainability measures increases, but also the range of applied targets, in assimilation of such sustainability guidelines.

Economic Sustainability and Further Non-Financial Targets

This section presents a qualitative analysis of the economic performance targets. As stated above, this paper concentrates on the tie of executive compensation with sustainability performance measures, which imply a long-term orientation. Hence, by contrasting the DJIA and the DAX for the years 2009 and 2012, this analysis examines, whether the contracts

contained economic targets designed to foster a long-term performance. That also encloses non-financial measures that in turn are drivers of long-term economic prosperity.

Introduction of the Specific Applied Targets

With respect to the *long-term economic dimension*, the installed performance targets were in essence traditional financial performance measures, but tied to the achievement of long-term results (i.e. in this case more than 3 years, see previous section). Hence, the focus of this study is not to discuss financial measures in detail, but the frequency of their tie to long-term incentive plans in the sense of a sustainable development. That is of interest, as many corporations generously praise a long-term orientation – but how does the practice look indeed? The practice of implementing these targets in the compensation contracts varies strongly among the examined corporations. The targets are tied to cash-based bonus components, equity-based awards or both. The used targets group in Share Price Development, Profitability, and Liquidity. Share Price Development aims at generating long-term shareholder value and therefore comprises likewise according ratios such as total shareholder return (TSR), earnings per share (EPS), the growth of enterprise value, and further sporadic used market value ratios. Profitability measures the ability of the executive to generate profit by effectively using the corporate resources. That includes targets such as return on assets (ROA), return on sales (ROS), return on equity (ROE), growth rates (e.g. sales, earnings), operating/net income, or earnings before interest and tax (EBIT). Liquidity measures shall ensure that a corporation is able to meet its financial obligations and has sufficient resources such as for investments or acquisitions. That also includes solvency, cost management, and (free) cash flow measures.

Analysis of Economic Sustainability Targets for the DJIA and DAX

The picture of the DJIA and DAX corporations for the economic targets with long-term orientation was very similar for 2009 as well as 2012 (see table 3): the primary focus lied on fostering a long-term positive share price development. In 2009, of all corporations with long-term economic performance targets, 67 % (20 contracts) in the DJIA and 50 % (15 contracts) used according measures. That number assimilated in 2012 at around 60 % with a slight decrease in the DJIA and increase in the DAX contracts. The second most common applied measure was profitability. The results show for 2009 that one third of the DJIA (10 contracts) and with one sixth half as many of the DAX (5 contracts) used according measures. Again, for 2012, the picture for the DJIA and the DAX leveled off at around 25 %. Fewer of the DJIA (7 contracts) and more of the DAX (8 contracts) executives were incentivized towards profitability. The largest difference concerns liquidity: that measure finds much more

consideration in the DJIA, with around 23 % in 2009 or 17 % in 2012. That measure was found only in few DAX long-term plans (2 in 2009, 1 in 2012). Finally, it has to be stated that some corporations shifted the economic performance targets in the period investigated from long-term to shorter performance periods or vice versa and hence did not abandon a target completely or install it from scratch.

Economic Targets with long-term Orientation	Share Price Development		Profitability		Liquidity	
	2009	2012	2009	2012	2009	2012
3M	○	●	○	-	○	-
American Express	○	-	-	●	-	-
AT&T	-	-	-	-	-	-
Boeing	○	-	-	-	-	-
Caterpillar	○	●	○	-	○	-
Chevron	○	●	-	-	-	-
Cisco Systems	-	●	○	-	-	-
Coca-Cola	○	●	-	●	-	●
E.I. du Pont Nemours	○	-	-	-	-	●
Exxon Mobile	○	●	-	●	-	-
General Electric	○	-	○	-	○	-
Goldman Sachs	-	●	-	●	-	-
Home Depot	○	●	○	-	-	-
Intel	○	-	-	-	-	-
IBM	-	-	-	-	-	-
Johnson&Johnson	○	●	○	●	○	●
JP Morgan	-	●	○	-	○	-
McDonald's	○	●	-	-	-	-
Merck & Co	○	●	-	-	-	-
Microsoft	-	-	○	●	-	-
Nike	○	●	-	-	-	-
Pfizer	○	●	-	-	-	-
Procter&Gamble	○	●	-	-	-	-
Travelers Companies	-	-	-	-	-	-
United Technologies	○	●	○	●	-	●
United Health	○	-	-	-	○	-
Verizon	-	-	-	-	-	-
Visa	-	-	-	-	-	-
Walmart	-	-	-	-	-	-
Walt Disney	○	●	○	-	○	●
	20	17	10	7	7	5

Economic Targets with long-term Orientation	Share Price Development		Profitability		Liquidity	
	2009	2012	2009	2012	2009	2012
Adidas	-	-	-	-	-	-
Allianz	○	-	-	-	-	-
BASF	○	●	-	-	-	-
BAYER	-	●	-	-	-	-
Beiersdorf	○	●	-	-	○	-
BMW	-	-	-	-	-	-
Commerzbank	○	●	-	●	-	-
Continental	-	-	-	-	-	-
Daimler	-	-	○	●	-	-
Deutsche Bank	-	●	-	-	-	-
Deutsche Boerse	○	-	-	-	-	-
Deutsche Lufthansa	○	●	-	-	-	-
Deutsche Post	○	●	-	-	-	-
Deutsche Telekom	-	●	-	●	-	-
E.ON	-	●	-	●	-	-
Fresenius Medical Care	○	●	-	-	-	-
Fresenius	-	●	○	-	-	-
HeidelbergCement	-	●	-	●	-	-
Henkel	-	-	-	-	-	-
Infineon Technologies	○	●	-	-	-	-
K+S	○	-	-	●	-	-
LANXESS	○	●	○	-	○	-
Linde	○	●	-	-	-	-
Merck	-	-	-	-	-	-
Munich RE	○	-	-	●	-	-
RWE	-	●	-	-	-	-
SAP	○	●	-	●	-	-
Siemens	○	-	-	-	-	-
ThyssenKrupp	-	●	○	-	-	-
VW	-	-	○	●	-	-
	15	18	5	8	2	1

Table 3: Summary of long-term Economic Targets (DJIA; DAX)

Analysis of Further Non-Financial Targets for the DJIA and DAX

In addition to these direct financial targets, the underlying executive compensation contracts contained further, non-financials (see table 4). As these have also economic effects and are in turn drivers of long-term growth or prosperity, they are outlined briefly: in 2009, particularly the DJIA contracts contained further non-financial targets. The most used targets were Leadership Ability, Innovativeness, and Competitive Edge, which also refers to an improvement of the market position. Further, some performance incentives focused on stakeholders with the targets Customer Satisfaction or Loyalty as well as Employee Loyalty. The latter is not included within the social targets, as the corporations aim at minimizing the

fluctuation rate due to the potential costs involved. An additional target was Production Quality and Productivity as well as Corporate Development, which refers to strategic growth and expansion. As the understanding of Corporate Development is not further specified, it is listed here instead of as direct financial target. In addition, the executives were measured in their Individual Performance and in the achievement of Risk Reduction. Within the DAX compensation contracts, these targets were used only sporadic in 2009 and although the number slightly increased in 2012, the DJIA corporations still predominated. The DAX contracts additionally installed Interest of Stakeholder and Supplier as performance targets, mainly in 2012. Overall, as the majority did not further explicate or quantify these targets, their definition and application is difficult to comprehend.

Target Focus	2009		2012	
	DJIA	DAX	DJIA	DAX
Leadership Ability	12	-	8	2
Innovativeness	11	-	10	1
Competitive Edge	11	1	5	2
Customer (Satisfaction, Loyalty)	7	1	6	6
Production (Quality, Productivity)	4	1	7	1
Employee (Loyalty)	6	-	5	-
Corporate Development	5	1	3	1
Risk Reduction	3	-	5	-
Individual Performance	3	-	4	-
Interests of Stakeholder	-	1	-	2
Supplier	-	-	-	2

Table 4: Summary of Further Non-Financial Targets with Long-Term Incentive

6.2. Sustainability Targets in Executive Compensation: General Disclosure Quality (RQ2)

Overall, the disclosure quality of the sustainability targets was very poor. That refers to the granularity and transparency of the disclosed details on the tie of executive compensation. On the one hand, in most cases the specific targets are listed without a precise definition (e.g. “health”, “social responsibility”). Generic labels conceal the precise meaning and purpose of the applied targets and make a thorough understanding and overall comparison difficult. In some cases, even no concrete targets are named and instead it is referred to the level of the social or environmental dimension (e.g. “strong results in the area environment”, “social targets”). Further, it remains unclear what specific metric or indicator is used to measure these targets (such as CO₂-emission reduction or successful implementation of health improvement program). On the other hand, no precise target levels are declared (such as 0.5 % reduction of the CO₂-emissions or 30 % of the employees measurably participate in the health program). If the target levels would reflect those disclosed in the sustainability report or other sections, it

had to be indicated. Therefore, it is not transparent how the concrete goal achievement and the paid compensation interrelate. In some cases, it is only referred to the “individual assessment” of the compensation committee or outlined that the quantitative and qualitative assessments vary based on individual responsibilities and business functions of the executive. A further salient observation is that in 80 % of the DJIA compensation contracts in 2009 and 2012 it was explicitly highlighted that the main rationale of the compensation design was to create long-term shareholder value. Additionally, the corporations’ strive for further social and environmental targets has been mentioned. The DAX corporations, on the other hand, clearly emphasize their sustainability focus in the context of the compensation report with 60 % of the corporations in 2009 and 93 % in 2012. Nevertheless, some of these only postulated sustainability but did not apply measures of the triple bottom line in the compensation contracts.

6.3. Leading Sustainability Guidelines and Executive Compensation (RQ3)

This section discusses the results against the backdrop of the corporations’ conformity with the leading guidelines of the UN Global Compact and the GRI in order to proof whether general sustainability efforts translate into executive compensation. The United Nations Global Compact, as discussed above, aims at fostering sustainable business practices and therefore encompasses ten principles that refer to the areas human rights, labor standards, the environment, and anti-corruption. In voluntarily joining the UN Global Compact, companies commit to declare the status of the principles’ implementation annually, a requirement to be listed as active member. That represents the “Communication on Progress” (COP) statement to the stakeholders, which reports on the progress and development of the principles integration within the corporate strategy. The purpose of the GRI is to issue Sustainability Reporting Guidelines to present a proper, comparable and transparent sustainability reporting to stakeholders. The guidelines and indicators cover the areas economic, environmental, labor practices and decent work, human rights, society, and product responsibility. The application or adherence levels of the guidelines “G3” generation are C, B, A, ascendant in their information content. Hence, a report of level A is most detailed. An additional “+” indicates that the report has been verified by an external audit. Since 2010, the GRI and UN Global Compact have been cooperating, which led to an integration of the ten principles of the UN Global Compact into the GRI guidelines and indicators. In May 2013, the GRI launched its fourth generation Sustainability Reporting Guidelines (G4) with a currently ongoing transition phase. The Guidelines offer the options “core” (essential elements of a sustainability report) or “comprehensive” (requiring additional Standard Disclosures of the organization’s strategy and

analysis, governance, and ethics and integrity) for a company to prepare its sustainability report ‘in accordance’ with the guidelines.

The corporations’ conformity to these guidelines in 2012 is shown in table 5. The information is based on the “participant search” of the UN Global Compact and GRI websites (UN Global Compact, 2014; GRI, 2014). A conformity to the Global Compact is given with “+”, meaning the corporation is active member. The conformity with the GRI guidelines is demonstrated by the concrete level. Some corporations do not further declare their application level of the guidelines, i.e. the level is “undeclared”. As outlined above, the use of sustainability targets in compensation contracts as well as the application of the guidelines were not well established in 2009 so that the analysis focuses on 2012. With respect to the GRI standards, particularly an application level of B and higher is of interest as it requires a separate section on the disclosure of the integration of sustainability aspects in executive compensation (i.e. section 4.5 in G3 or onwards G4-51).

DJIA	UN Compact	GRI (Level)	DAX	UN Compact	GRI (Level)
3M	+	C+	Adidas	–	B
American Express	–	–	Allianz	+	A+
AT&T	–	B	BASF	+	A+
Boeing	–	–	BAYER	+	A+
Caterpillar	–	–	Beiersdorf	–	ud
Chevron	–	ud	BMW	+	A+
Cisco Systems	+	ud	Commerzbank	+	A
Coca-Cola	+	B+	Continental	+	B
E.I. du Pont Nemours	+	A	Daimler	+	A+
Exxon Mobile	–	ud	Deutsche Bank	+	A+
General Electric	+	A	Deutsche Boerse	+	A+
Goldman Sachs	–	–	Deutsche Lufthansa	+	–
Home Depot	–	–	Deutsche Post	+	B+
Intel	+	A+	Deutsche Telekom	+	A+
IBM	–	A	E.ON	+	B+
Johnson&Johnson	+	ud	Fresenius Medical Care	–	–
JP Morgan	–	B	Fresenius	–	–
McDonald's	–	ud	HeidelbergCement	–	A+
Merck & Co	+	A	Henkel	+	B
Microsoft	+	ud	Infineon Technologies	+	B+
Nike	+	B	K+S	–	B
Pfizer	+	B	LANXESS	+	B+
Procter&Gamble	–	B	Linde	+	A+
Travelers Companies	–	–	Merck	+	A+
United Technologies	–	–	Munich RE	+	B
United Health	–	–	RWE	+	A+
Verizon	–	–	SAP	+	A+
Visa	–	–	Siemens	+	A+
Walmart	–	B	ThyssenKrupp	+	B
Walt Disney	–	B	VW	+	A+

UN Global Compact: “+” means “active member”; GRI: C, B, A = application level with ascendant information content; ud: application level undeclared; “+” indicates a verification by external audit;

Table 5: UN Global Compact & GRI Conformity of DJIA and DAX (2012)

Table 5 shows that in 2012, 24 DAX and 11 DJIA corporations are participants of the UN Global Compact, integrating the ten principles in their corporate strategy, meaning more than twice as many German than U.S. corporations. With respect to the GRI, in 2012 27 DAX and 20 DJIA corporations comply with the official standard in their reporting. The results show that the DAX corporations occupy the leading role in conforming to sustainability standards, not only in numbers but also in higher GRI application levels. Of these DAX corporations, 96 % declared an application level of B or A, and 73 % of these is verified by external audit. Among the DJIA corporations by contrast, were only 65 % with a declared application level of B or A, and 15 % with external audit verification. An analysis of the correlation of the implementation of sustainability targets in executive compensation and the conformity to social, environmental, and long-term economic performance shows interesting results (see table 6). Different than one would expect, there is no significant, positive correlation (Pearson). The values show a weak positive correlation between environmental and long-term economic performance targets in compensation contracts and the corporations' conformity to the UN global compact, which is, however not significant. There is a very weak negative correlation of the three different target dimensions and the GRI, but again the correlation is not significant. In summary, the corporations' conformity to leading sustainability guidelines or standards plays an important role in corporate governance in general – but it is not an indicator for the consideration of sustainability targets in further governance mechanisms, such as in executive compensation.

	Social	Environmental	Economic
UN Global Compact	0.006	0.133	0.111
GRI*	-0.059	-0.021	-0.099
*level B or higher (undeclared is regarded less)			
No significant correlation at 0.01, 0.05 or 0.1 level (2-tailed)			

Table 6: Correlation of Sustainability Targets and Guidelines (2012)

7. Discussion

In conclusion, with respect to the consideration of sustainability performance targets within executive compensation, the study shows the following results:

The DAX and the DJIA differ in their focus. The executive compensation design policies of the DAX and DJIA differ in some points. The DJIA corporations are oriented much more towards a value creation primarily for the shareholders, whereas the DAX corporations aim at a more balanced stakeholder orientation. That is indicated by the proxy statement and annual report portrayals as well as by the performance target incentives. However, in 2009, the DJIA corporations were in the lead in implementing social, long-term economic and non-financial performance targets with indirect economic effects. The DAX corporations equalized in

general, for what the implementation of the Act on the Appropriateness of Management Board Remuneration in 2009 presumable played an important role. In 2012, the DAX corporations were even better represented in the conformity with the leading sustainability guidelines of the UN Global Compact and the GRI.

Lack of transparency and comprehensibility. Overall, with a few exceptions, the disclosure quality of the sustainability performance targets used in executive compensation contracts was insufficient in several aspects. First, a comparison or comprehension of the specific applied social, environmental or (long-term or indirect) economic target was difficult as in most cases they were stated without precise definition (e.g. “protection of the environment”, “health”, or “individual performance”). Second, the majority did not declare precise target levels for the specific measures that should be achieved. Last, the concrete achievement of these targets was mostly not disclosed.

Social and environmental targets were considered weakly. The corporations acknowledge the importance of and increasingly focus on a successful implementation of sustainable business operations. That manifests in the compliance with leading guidelines and standards as well as general passages of the proxy statements and annual reports. Nevertheless, this does not translate to the same extent into a tie of executive compensation with according sustainability measures. Whereas long-term economic and further non-financial measures with indirect economic effect were represented strongly in compensation contracts in 2009 and 2012, the corporations considered the remaining sustainability dimensions weakly. With respect to the social targets, the DAX corporations rose up from 2009 to 2012 and the DJIA remained at the same level, so that in 2012 around one third of the DAX and two third of the DJIA executive compensation packages included social performance targets. The environmental targets were merely considered in the DAX and DJIA contracts in both 2009 and 2012, although a slight increase can be reported. In addition, there is overall a strong focus on certain measures. Regarding the social dimension, the installed incentives were focused on employee satisfaction and motivation. Mostly, only environmental protection represented the environmental dimension. The long-term economic performance targets predominantly awarded a positive share price development. Additional non-financial measures with indirect economic effect were found primarily in the DJIA compensation contracts. In summary, although there was an increase of social and environmental performance targets in executive compensation contracts, still the incentives towards economic targets predominated by far. The applied targets often did not reach beyond areas that are covered anyhow by the core business or have to be fulfilled due to external regulations or stakeholder pressure (such as ensuring a safe workplace).

8. Conclusion

In recent years, concerns around corporate sustainability moved beyond the state of ethical, fundamental debates and today, its successful implementation became a focal point. Besides other stakeholders, also the particularly powerful group of (potential) investors have exceedingly attached importance to sustainable business practices. A huge SRI movement emerged, which is also associated with corresponding high expectations for the corporations in proceeding successful sustainability strategies. In this context, executives play an important role. However, do they have the right incentives to steer the business accordingly? In aligning the investors and executives' interest, performance-related compensation has proven to be an effective instrument in other contexts. Hence, it should be leveraged for the context of corporate sustainability – it already has been highlighted as the missing link to fuse sustainability with core business activities. Therefore, this paper first analyzed to what extent sustainability targets of the environmental, social or (long-term) economic dimension were considered within executive compensation contracts. Therefore, a content analysis of the annual reports and proxy statements of 60 publicly traded companies listed on the leading DJIA and DAX indices was conducted. The study presented a comparison of the DJIA and DAX corporations as well as an overview on the major developments since 2009, i.e. a period influenced by the aftermath of the financial crisis up to three years later in 2012. Second, the disclosure quality of sustainability targets tied to executive compensation was examined. Finally, it was investigated whether the corporations' conformity with the leading sustainability guidelines translates into executive compensation in form of a link with sustainability targets. In summary, the study reveals that executive compensation is not fully leveraged to foster corporate sustainability. Both practice and further research can draw on the presented results to advance investigations on the success factors for an effective implementation of sustainability strategies considering the crucial role of executive compensation.

First, the results provide an overview of the current practices in linking sustainability performance targets to executive compensation along with a discussion of the specific sustainability targets that were used. This may serve (1) corporations as a benchmark for challenging their own practices and (2) investors with sustainable strategies to proof whether (potential) investment objectives are steered accordingly. Further, the results show that the transparency and substantiation of the compensation design should be enhanced. The application of environmental targets – especially against the backdrop of the challenges of climate change and the large attention such as on the carbon disclosure project – as well as of social targets in compensation leaves much room for improvement. It is necessary to reduce

potential conflicts for the executives in fostering the integration of sustainability strategies in the corporate heart while having other short- or mid-term financial incentives. Thannisch (2011) claims that around 25 % to 50 % of the average executive compensation should be tied to sustainability targets. That is reasonable as social and environmental targets can contribute to a long-term financial stability and thus, corporations may create effects. Hence, it is an important task to consider these dimension in an integrated, balanced manner. In this course, compensation contracts should increasingly be designed such that a nonperformance in one dimension cannot outweigh another and that exorbitant compensation levels do not go along with poor sustainability performance.

This study also provides starting points for further research. It especially aims at stipulating the interdisciplinary discourse between sustainability and compensation research. Although much research investigated how to foster the implementation of corporate sustainability, many corporations still struggle in practice. Hence, as the study shows that executive compensation is not fully leveraged, the implementation of sustainability measures in compensation design should be investigated in more detail. Such interdisciplinary research is needed as different compensation components may not be suitable likewise or provide proper incentive effects in the interplay with sustainability targets. The presented, currently applied sustainability targets thereby provide a potential starting point for further studies. Thereby, studies should draw on well-established knowledge of traditional compensation research. Furthermore, a major challenge is the difficult measurability of sustainability targets, which is certainly also obstructive for their enhanced application in compensation contracts. Research should therefore expedite a thorough understanding and operationalization of corporate sustainability along with according measures. Only if corporations fully understand and confidently implement sustainability targets in general, they can properly draw on them in measuring the executives' performance. Dr. Heinrich Hiesinger, CEO of ThyssenKrupp expressed it as follows: "There is still a long track towards mature quantitative sustainability indicators, so it is necessary to pursue integrated thinking in order to adequately quantify the contribution of sustainability to business performance" (Accenture and UN Global Compact, 2013). Finally, the results reveal that while the corporations' conformity to leading sustainability guidelines or standards plays an important role in corporate governance in general, it is not an indicator for the consideration of sustainability targets in further governance mechanisms, such as in executive compensation. Hence, this might be an indicator that further research should be dedicated to develop guidelines and standards on sustainable executive compensation for the design of proper, well-founded contracts and their transparent and comprehensible reporting.

Overall, the study reveals that the incentives on executive level might not be in line with overall corporate sustainability strategies. The results, however, do not reflect the underlying corporations' general corporate sustainability performance as the analysis concentrates specifically on executive compensation. The scope does also not enclose a discussion of performance-related pay in general. This study shall furthermore enhance awareness for sustainable pay and thus stimulate the interdisciplinary discourse between traditional compensation and sustainability research. Such knowledge could contribute to the numerous political or non-profit initiatives to promote sustainable business operations and lead to an adjustment of according laws and regulations.

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V. Summary and Future Research

This chapter summarizes the dissertation along with key findings and outlines opportunities for future research.

1. Summary

The overarching objective of this dissertation was to study corporate performance management considering digitalization, with particular focus on the rapidly increasing digital connectedness, as well as sustainability from an information systems perspective. In the motivation section, these two megatrends of today's society along with their implications for organizations were outlined. Furthermore, the instruments of corporate performance management, namely performance measurement systems and performance measures were delineated. Based on these foundations, chapter II was dedicated to investigating PMS – regardless of a particular area of application – to provide the basis for effective decision support. In the course of this, the presented foundations of corporate performance management were extended. On that basis, chapter III and IV then focused on examining performance measures, an integral part of PMS. As they are also ultimate carrier of performance information they build the logical starting point for adjustments such as due to changes in the business environment. Hence, specifically their application in the context of digitalization, with particular focus on digital connectedness, as well as sustainability was studied. This section summarizes the key findings of the corresponding research papers embedded in this dissertation.

- Chapter II was dedicated to necessary adjustments of PMS. to serve as effective decision support. Specifically, the first research paper investigated how existing PMS can be consolidated in line with the informational and economic challenges of information provision. After theoretical foundations on PMS were clarified, informational and economic requirements on PMS as design products as well as for the design process were extracted from literature. Based on these requirements, existing approaches to PMS design and consolidation were analyzed to delineate the research gap and foundations for the decision framework. In a second step, the paper derived an objective system from the requirements for PMS as design products, which was operationalized by corresponding mathematical functions. These were integrated into an overall objective function, which reflected the complementary and conflicting relationships among the objectives. Thereby, both the measures of existing PMS and the interdependencies among these measures were considered. Finally, the decision framework's applicability to consolidate existing PMS against the background of partially conflicting informational and economic objectives was

verified based on a feature comparison, prototype construction, and a real-world application. Thereby, it allows for reducing the information processing complexity and the costs for operating and maintaining the supporting infrastructure to a reasonably balanced extent to which a consolidated PMS covers the information requirements and aligns with the company's objectives at a corporate level.

- Chapter III investigated how organizations can successfully guide their OSN initiatives based on performance measures that account for the proceeding digital connectedness to leverage the opportunities of OSN.

The second research paper focused on the identification of influential users in OSN, a vital challenge for successful viral marketing campaigns. It first aimed at synthesizing approaches to measure the influence of users and to identify the most influential users in OSN. The second objective was to derive a research agenda on the identification of influential users by delineating research gaps. As foundation, fundamental research on social influence, influential people, and their identification in social networks before the rise of OSN was outlined. Next, based on a structured literature review, the growing number of publications on the identification of influential users in OSN was analyzed based on three research questions, which were extracted from seminal literature: (1) How are influential users characterized in the context of OSN? (2) Which approaches have been developed and applied for the identification of influential users in OSN? (3) How have these approaches been evaluated and which implications have been derived? The analysis revealed that the majority of existing studies characterizes influential users as particularly well-connected and active users. Furthermore, two review streams of research on the identification of influential users could be identified: one stream focuses on the users' strategic location, for instance by applying well-known centrality measures originating from SNA. The second major research stream is dedicated to solving the influence maximization problem by applying diffusion models and (greedy) algorithms to identify influential users in OSN. The review moreover showed that most marketing-oriented articles (mostly from the first research stream) draw on real-world datasets of OSN for their approaches' evaluation. The rather technical-oriented papers (mostly from the second research stream) follow a more theoretical approach by usually evaluating their artifacts by formal proofs. The research paper finally derived a research agenda from the review findings, which highlights starting points for future research.

The third research paper relates to the current hype among organizations for promoting their fan pages in OSN. It aimed at examining the economic effects of the ratio of fans to non-

fans of a company's fan page in a customer portfolio under risk diversification aspects considering eWOM. First, related work regarding the influence of eWOM generated and disseminated in OSN on the company value in general, on the customer value specifically, and on customer portfolio optimization was reviewed. According to prior research, fans are exposed to a higher volume of eWOM with mainly positive sentiment, leading to higher expected per capita cash flows generated by fans than those generated by non-fans. However, as eWOM generated on fan pages can be negative as well, which negatively affects cash flows and related economic measures, prior empirical findings indicate that the per capita cash flows generated by fans are also more volatile. Therefore, a model was developed based on prior work on customer portfolio optimization related to portfolio selection theory by incorporating these preliminary empirical results of the economic effects of eWOM into customer lifetime value calculations. The model's validity and utility was evaluated by means of a case example based on real-world data. In the course of this, the assumption of the relationship between economic measures and eWOM generated in OSN could be tested and confirmed allowing for a meaningful application of the model. Hence, it could be demonstrated, that a sheer maximization of fans in a customer portfolio must be critically reflected and that diversifying the risk in terms of the cash flows' volatility of fans by keeping a share of non-fans – or even increasing it – might be economically reasonable.

- The objective of chapter IV was to investigate how corporate performance management can support organizations in their challenge of implementing sustainability strategies. Initially, the fourth research paper highlighted the role of performance-related executive compensation for the implementation of corporate sustainability strategies based on prior literature along with theoretical foundations. Furthermore, the paper examined the current state of the alignment of executive compensation with social, environmental and economic performance targets. For that purpose, an empirical analysis of the executive compensation packages of 60 publicly traded companies listed on the US Dow Jones Industrial Average Index as well as on the German Stock Index was conducted for the years 2009 and 2012. First, an overview was presented on how many corporations incorporated social, environmental and economic performance targets, respectively within their executive compensation contracts. Next, the paper discussed the disclosure quality of the sustainability targets linked to compensation and analyzed qualitatively which specific targets were applied to what extent. Finally, the results were discussed against the backdrop of the leading sustainability guidelines to prove whether a conformity in these standards translate into executive compensation in form of a link with sustainability targets. The

results revealed that the alignment of sustainability strategies and executive rewards is still in its infancy and that rewards as core corporate performance management instrument is not fully leveraged to foster sustainability implementation.

In conclusion, the research papers included in this dissertation contributed to research related to the different corporate performance management instruments with particular focus to how to respond to massive changes in the business sphere. Despite the presented findings, there are further unresolved issues which could be addressed by future research.

2. Future Research

This section presents potential starting points for future research. These are outlined for each research paper embedded in this dissertation, respectively.

- The development of the decision framework for PMS consolidation and its applicability presented in the first research paper (chapter II) are beset with some limitations that motivate future research:
 1. As some of the assumptions underlying the objective functions of the decision framework are simplifying, future research should challenge which of these assumptions might be relaxed. For instance, the model assumes that the company's objectives are captured by means of a single top measure, that the interdependencies among measures are linear and constant, or that the heterogeneity of the measures enclosed in a PMS can be quantified by means of the number of different units. Nevertheless, one has to weigh potential increases in closeness to reality due to relaxed assumptions against an increase in the decision framework's complexity and the additional effort of eliciting values for the input parameters.
 2. The scope of the decision framework could be extended from currently a single business unit to multiple business units. Thus, the fractional contribution of other business units to the alignment with top measures and potential diversification effects could be incorporated in the course of model extensions.
 3. For the practical applicability of the decision framework it would be beneficial to develop further approaches for the assessment of valid values for the input parameters of the decision framework's objective function. The paper currently proposes starting points, but by means of multiple case studies and extensive discussions with subject matter experts from industry, the validity might be enhanced.

4. In order to counteract uncontrolled growth of PMS and thus to reduce consolidation efforts as well as to keep them up to date, further work could embed the decision framework into an ongoing, continuous review circle for existing PMS.
- The results of the structured literature review presented in the second research paper (chapter III) on the identification of influential users in OSN might be broadened by incorporating some further aspects in future research:
 1. The paper focused mainly on user-oriented OSN. Hence, one could extend the review for content-oriented OSN and sites for microblogging such as Twitter, i.e. all different types of social media platforms as this might unveil certain findings that have been derived specifically for that context.
 2. Further research should incorporate the influence of offline interactions. That is as the impact of online influence might be affected by factors of offline interactions and vice versa. Thus, one could also derive commonalities and differences of social influence in online and offline settings. On that basis, organizations could properly align multi-channel activities and thus benefit from targeting influential users jointly online and offline.
 - With respect to the third research paper (chapter III), the suggested model for an analysis of the economic effects of the ratio of fans to non-fans implicates some assumptions and limitations. Future research could , which might be and limitations which could be enhanced by future research:
 1. As numerous existing research already demonstrated the relationship between economic measures and eWOM generated in OSN, the paper assumed this interrelation in developing the optimization model. Although, based on the application of real-world data this assumption could be successfully tested and confirmed, a further in-depth investigation applying our model within (empirical) research should be conducted to explicitly incorporate the relationship between eWOM and per capita net cash flows.
 2. The paper abstracted from reality by focusing on two segments (fans and non-fans). However, as the model is stated in a general form, further, consecutive research might incorporate more customer segments, for instance to depict a finer grained segmentation based on other customer characteristics.
 3. Furthermore, the optimization models application might unveil potential adjustments to the existing customer portfolio (e.g., acquisition of further non-fans). As this might be

costly and raise additional strategic issues, the model might be enhanced by integrating such interdependencies within further model enhancements in future research.

- The fourth research paper (chapter IV) relates to the role of executive compensation for supporting the implementation of sustainability strategies. Therefore, it empirically analyzed compensation contracts of leading publicly traded corporations. The presented results could be enhanced by future research in the following ways:
 1. The study provides only fundamental theoretical background to frame the study. The results could be enriched and compared to well-established knowledge of traditional compensation research.
 2. The scope of the paper does not enclose a general discussion of performance-related pay. Future studies could investigate the relation of sustainable pay policies and its effect on the environmental and social performance of corporations.
 3. Since a major challenge for organizations is the difficult measurability of sustainability targets, it is certainly also obstructive for their enhanced application in compensation contracts. Research should therefore expedite a thorough understanding and operationalization of corporate sustainability along with according measures. Only if corporations fully understand and confidently implement sustainability targets in general, they can properly draw on them in measuring the executives' performance.
 4. The study's results indicate that more concrete guidelines and standards on sustainable executive compensation are required for the design of proper, well-founded contracts tied to sustainability targets and their transparent and comprehensible reporting.

Taken together, this dissertation aimed at contributing to the question of how the corporate performance management instruments can be properly aligned to effectively respond to challenges arising from the megatrends of digitalization, with particular focus on digital connectedness, as well as sustainability. Although several corresponding research questions could be addressed, these megatrends remain hot topics with wide-ranging impacts urging for further investigations. Hence, also starting points for future research were outlined relating to corporate performance management as central vehicle to support organizations in coping with challenges of change and to seize the opportunities of transformations.

Research Paper 1:

With kind permission from Elsevier: Decision Support Systems: “A decision framework for the consolidation of performance measurement systems.” Grosswiele, Laura, Maximilian Röglinger, and Bettina Friedl. 54(2), 2013, 1016-1029. The published version of the paper can be accessed via DOI: 10.1016/j.dss.2012.10.027.

Research Paper 2:

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