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Digitally unified reporting: how XBRL-based real-time transparency helps in combining integrated sustainability reporting and performance control

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ABSTRACT

In this paper, I address the call for a "new approach to sustainability reporting" (Lubin and Esty, 2014) based on the present "sustainability gap" and propose the concept of "digitally unified reporting." This is achieved by reviewing two major trends from distinct bodies of literature: "integrated reporting" from the sustainability field and unified data based "XBRL-integrated reports" as established in financial reporting making use of the digital standard XBRL (eXtensible Business Reporting Language). Based on a systematic literature review, eight trend statements are derived pointing at gaps and issues in the field of sustainability reporting and management. Following this review, I propose a new concept called "digitally unified reporting" that addresses these issues. The core contribution is an XBRL-based approach to sustainability reporting that combines digital data management of sustainability performance measurement with digitally standardized sustainability reporting. To advance theory, "digitally unified reporting" is defined and discussed and positioned as a "twin track approach" to sustainability reporting (Burritt and Schaltegger, 2010) that provides both an inside-out and an outside-in perspective on sustainability reporting and management. The major advancement and theoretical contribution of the proposed concept is a *time-ontological shift* due to *24/7/365 digital transparency*. This proposed shift is from retrospective reporting on past performance to digitally enabled and interoperable real-time transparency of performance measurement and reporting for managers and external stakeholders. Finally, the concept is compared to current conventional reporting approaches.

1. Introduction: addressing the "sustainability gap"

This research[1] is motivated by the "sustainability gap" recently described by Lubin and Esty (2014) to highlight the growing disconnect between the importance of sustainability to many corporate strategies and its lack of relevance to mainstream investors. To close this gap, Lubin and Esty (2014) demand a "new approach to sustainability reporting". This article aims to contribute to the closure of the proclaimed sustainability gap, not only to provide more relevant data to investors, but also to contribute to an overall "more sustainable society" as demanded by Eccles and Armbrester (2011: 14), for example. To contribute to this transformation, two major trends are reviewed and conceptually combined in this article: "integrated reporting," bringing together financial and non-financial disclosure content in a single document, and "XBRL-integrated reports," making use of XBRL-based (eXtensible Business Reporting Language) data taxonomies and repositories, as observed in financial reports to regulators and investors. "XBRL-integrated reports" have a common data repository, so report data can be obtained directly from the common data source – in real time. The literature review was used to arrive at eight trend statements. On a theoretical level, sustainability reporting is embedded conceptually into the framework of Burritt and Schaltegger (2010), who distinguish between the inside-out and the outside-in perspective of sustainability reporting and accounting. They propose the so-called "twin track approach," contributing to both internal managers and external stakeholders so as to facilitate better sustainability information management to arrive at deliberative action through accounting information. I argue that XBRL in particular can help to close this "sustainability gap". XBRL is a digital business reporting standard and taxonomy introduced for financial reporting to achieve higher levels of

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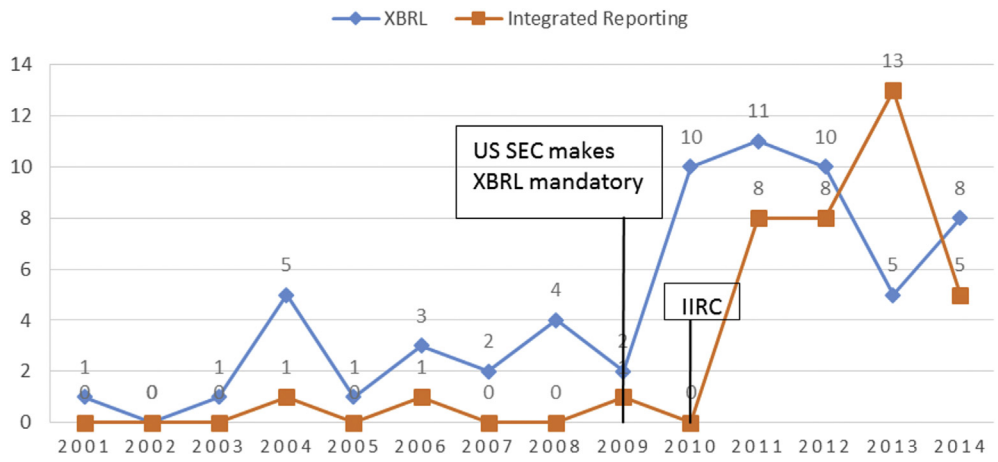

Fig. 1. Frequencies of reviewed journal articles on XBRL and integrated reporting.

comparability and instant access to a common data repository. XBRL is already established in financial reporting and since 2009 the U.S. Securities and Exchange Commission (SEC) has required a digital XBRL-based financial statement. This advancement is also consistent with Eccles and Armbrester, who categorize the transformation brought about by integrated reporting and computing as "disruptive ideas" that "enable companies to make much more informed decisions about how they are using financial, natural and human resources to meet both financial and nonfinancial performance objectives" (2011: 14).

Therefore, in this paper, the two major trends of integrated reporting and XBRL-based integrated reports starting in 2009 and 2010 (see Fig. 1) are conceptually combined to arrive at a new concept called "digitally unified reporting" (DUR). I follow Watson and Monterio (2011: x) in describing the next stage in the evolution of business reporting as "interlinked reports showing operational and ESG [environment, social, governance] data." This unified and interlinked reporting concept will also allow companies to integrate practices within "operations and measuring and reporting on those integrated practices in an aggregated, machine-readable, XBRL format" (Watson and Monterio, 2011: 75). In line with this prospect, the concept of "digitally unified reporting" is suggested as a concept integrating reporting in data management and business communication (Oberholzer, 2011). The overall aim is to address the eight trend statements identified in the literature review to go beyond the "static document" paradigm toward involvement with strategy, objectives, performance, and reporting transparency. In theoretical terms, this integrative approach to reporting relies on the "twin track approach" of sustainability reporting (Burritt and Schaltegger, 2010) that combines a management and a stakeholder perspective. "Digitally unified reporting" is understood as a format for providing both tracks with accurate and reliable data.

The main contribution of the proposed concept can be seen by technologically and conceptually arriving at a reporting model that helps close the "sustainability gap" in both strategic and societal directions (chapter 5.1). Real-time transparency, as XBRL provides, is therefore a "logical choice for integrated reporting" with the overall effect of helping to "build trust in and credibility around data" (Monterio, 2013: 15f.). Thus, the major step ahead lies in the shift from retrospective reporting on past performance to real-time transparency. This shift is portrayed in this article as *time-ontological transformation* of reporting where digitally unified reporting combines integrated sustainability reporting with sustainability data management and performance control. This time-ontological shift is described in a comparison between conventional and digitally unified reporting (chapter 5.2). In closing, the article describes limitations of the proposed concept, such as setup costs, regulatory gaps, competitive disadvantages for first movers, and reduced incentives to develop sustainability innovations when following a standardized sustainability taxonomy and holistic transparency (Frías-Aceituno et al., 2013b).

2. Method of the review and sample selection

Literature reviews produce an overview and develop new concepts out of existing research. For this article, two literature reviews were conducted and the results were combined and synthesized into a conceptual contribution.

In the field of sustainability reporting, several literature reviews have been conducted by scholars to map the field (Lamberton, 2005; Thomson, 2007; Aras and Crowther, 2009) or to systematically develop new concepts and classification schemes (Burritt and Schaltegger, 2010).

To arrive at construct validity of the literature-derived concept of digitally unified reporting, a systematic and, given the sample selection approach, also a comprehensive literature review was conducted. As the concept builds on the merger of integrated reporting and XBRL-based integrated reports, the scholarly literature on both concepts was reviewed to reach reliability of the proposed concept. Based on the literature, gaps were identified for which the proposed concept of digitally unified reporting aims to provide solutions. Therefore, the literature review consisted of two parts. The sample selection criteria and the search for both parts was the same. To increase the replication logic of the research, each search term (see below) was used in the following databases: *communication and mass media complete, sage full text, emerald insight, science direct, springer link, wiley online, ulrichsweb,* and *jstor*. In the first part, the scholarly literature was selected by using integrated reporting as a search term. As the concept of integrated reporting is widespread in scholarly research, 37 articles were identified. For the second literature review on integrated reports, the search had to be broadened, as XBRL-integrated reporting is a concept rarely referred to in the scholarly literature. Therefore, the term XBRL was added to the search in titles, abstracts, and keywords. As a result, the second part of the literature review consisted of 63 articles.

The articles used[2] are marked with an asterisk (*) in the reference list at the end of the article. The sample selection process was

[2] The reference list of this article only contains those references actually cited in the article. A comprehensive list with the 37 + 63 articles selected can be requested from the author.

concluded in April of 2014. The following graph indicates the emergence and timeliness of the two concepts. For integrated reporting, only in 2011 did the frequency of publications start to gain momentum. Given the time lag in scholarly publication, this can be connected to the introduction of the International Integrated Reporting Council (IIRC) in 2011, which brought integrated reporting to corporate and scholarly attention. For XBRL, next to a minor peak in 2004 after the introduction of the standard, frequencies increased in 2010 with a peak in 2011, which might be explained by the SEC's 2009 decision to make XBRL a mandatory reporting format for financial data reported to the regulating authority. The interest in integrated reporting had its peak in 2013, and papers addressing XBRL have been less frequent since making XBRL mandatory in the U.S. Papers that address XBRL and sustainability issues or integrated reporting are not yet available. Some practitioners' papers can be mentioned (Watson and Monterio, 2011; KPMG, 2011, 2012; Monterio, 2013), but scholarly research to date has not been published extensively although the topic is discussed at accounting and business informatics conferences.

After reviewing the content of all selected articles, they were grouped into trend statements addressing the state of the art as well as existing gaps in the literature. This is addressed in the next chapter with the proposed concept of digitally unified reporting.

3. Review of integrated reporting

3.1. Trend 1: infancy and accelerated growth of integrated reporting

The acceptance and spread of non-financial reports has increased considerably in the last decade: today almost all publicly listed corporations (and increasingly also small and medium-sized enterprises (SMEs)) publish information on social and environmental issues (KPMG, 2011) in their sustainability or corporate social responsibility (CSR) reports. Non-financial reports can be seen as "responses to both public pressure and increased media attention" (Hooghiemstra, 2000: 56) to establish legitimacy (Arvidsson, 2011; Seele and Lock, 2014). Within sustainability reporting, one major trend is the shift toward integrated reporting, which is reflected by vast academic and corporate research on the topic, and the founding of the IIRC in 2010 (IIRC, 2011; Leuner, 2012; Tilley, 2012; Ioannou and Serafeim, 2011; KPMG, 2012). Integrated reporting here means that the former stand-alone sustainability or CSR report is integrated into the annual report, also referred to as "one report" (Eccles and Krzus, 2010). Some countries like South Africa, for example, have made it mandatory since 2009 for all publicly listed companies to publish in an integrated manner (Ioannou and Serafeim, 2011). One economic advantage of integrated reporting is its suitability for investors who demand more comprehensive and organized data and information regarding sustainability issues (Soyka, 2013; Ioannou and Serafeim, 2011; Churet and Eccles, 2014). However, in addition to investors, other stakeholder groups also benefit from the integration of sustainability issues in the annual report: "key stakeholders, such as customers, suppliers, employees and local communities" (Soyka, 2013: 13) are also particularly affected by integrated reporting.

Given the aspects mentioned, the increase in integrated reporting and related scholarly research displays two characteristics. First, as corporate reporting for decades involved financial reporting and only financial reporting, sustainability reporting is still in its infancy and many "deficiencies in comparability, consistency, reliability, and relevance" remain (Tschopp and Huefner, 2014: 565).

In addition, integrated reporting is being developed and adopted by corporations at an accelerating pace. Churet and Eccles surveyed 2000 companies and found that from 2011 to 2012, integrated reporting increased by 50% (Churet and Eccles, 2014).

In summary, the following trend statement is proposed:

T1: Although in its infancy, integrated reporting is a major trend in the industry and is growing quickly in the reporting world.

3.2. Trend 2: the promise regarding integrated reporting and lack of holistic integration

Integrated reporting has been introduced as a "new reporting paradigm that is holistic" (Adams and Simnett, 2011): By integrating disclosure on sustainability performance in annual reports, as suggested by the concept of integrated reporting, sustainability moves from the fringe of business operations and reporting to the center. Eccles and Saltzman (2011) hold that sustainability can be achieved through integrated reporting and Frias-Aceituno et al. (2013a) state that integrated reporting reduces confusion among readers of corporate reports and thus increases stakeholder participation in business management. The IIRC advocates for integrated reporting, claiming that it provides "concise communication about how an organization's strategy, governance, performance and prospects … lead to the creation of value over the short, medium and long term," in the context of its external environment and overall goals (Soyka, 2013).

In addition to the profit-maximization logic of integrated sustainability reporting, the concept also is seen to contribute to the overall promotion of sustainable development. This is observed by going beyond story telling (Abeysekera, 2013) and unspecific, lengthy contents (Wild and van Staden, 2013) of sustainability issues to contribute to "holistic transparency" (Frías-Aceituno et al., 2013b) and a more professional management of corporate sustainability with integrated reporting, so as to arrive at all-round credibility (Kolk, 2004). As integrated reporting is in its infancy, it often appears to be a mere tick-a-box exercise in adding what has been the stand-alone sustainability report as a designated chapter in the regular annual report. This fulfills the formal requirement of an integrated report, but nevertheless is far from the holistic approach it is meant to be conceptually by literally integrating sustainability issues throughout the report interwoven with financial data and performance. Unlike Lubin and Esty (2014) and Eccles and Armbrester (2011), who argue for a profit maximization rationale to integrate sustainability in business operations ("green to gold"), other scholars point to the political, cultural, and economic aspects influencing the release of integrated reporting on a voluntary basis (Dragu and Tiron-Tudor, 2013). This sustainability-driven strategy to promote integrated reporting is also consistent with the overall reasons to report identified by Kolk, where "facilitating the implementation of environmental strategy" and "greater awareness of broad environmental issues throughout the organization" are among the core reasons (Kolk, 2004: x). Engaging in integrated reporting also can be seen as an indicator of the seriousness of engaging in sustainability. Research has shown that companies voluntarily disclosing in an integrated manner also are more likely to have their sustainability disclosure externally assured (Sierra-García et al., 2013). Also, integrated reporting adds to the debate on accounting for intangible assets (Beattie and Smith, 2013), which also would contradict the solely business-driven rationale as proposed by the strategy scholars mentioned above.

In sum, integrated reporting may provide three benefits if developed fully: contribution to business as well as sustainability goals: internal and external benefits and managing regulatory risks (Eccles and Armbrester, 2011: 15).

However, the aspects mentioned above indicate that integrated reporting does not yet entirely live up to the promises associated

with the concept. Authors such as Krzus (2011) argue that integrated reporting is not reached yet but a task to be accomplished "if not now, when?" and Leuner (2012) even concludes that integrated reporting "takes hold" in further development. This critique of the underdeveloped potential of integrated reporting is in line with the suggestion to "establish national laws and protection mechanisms to promote and ensure holistic transparency" (Frías-Aceituno et al., 2013b). This finding is also supported when looking at the guiding principles of the IIRC that do not seem to be met by current reports. Hence, use of a standardized taxonomy is one way to reach consistency and comparability as well as connectivity of information (Monterio, 2013: 9) and even to go beyond (Soyka, 2013; Cheng et al., 2014).

Generally speaking, the claim of holistic integration of financial and non-financial reporting content and managerial practices is not yet met, given that integrated reporting is a "new reporting paradigm that is holistic" (Adams and Simnett, 2011) In this regard, new concepts such as "augmented sustainability reports" (Freundlieb and Teuteberg, 2012) have emerged to address the shortcomings of the prevailing status. In summary, the following trend statement is proposed:

T2: The promise of integrated reporting to provide more holistic transparency and to contribute to value creation by closing the gap between companies and investors is not yet fulfilled.

3.3. Trend 3 – "embryonic management practice": gap in integration of sustainability management and control in reporting

The chapter addresses the link between reporting and management practice in corporate sustainability. Here, particular emphasis is put on the increasingly important topic of impact measurement (Maas and Liket, 2011). Given the reasons to report (Kolk, 2004) and the guidelines of the IICR (2013) as outlined above, it is evident that reporting is not just a public relations (PR) exercise but is meant to help managers make informed management decisions that are also of use for investors in making informed investment decisions. Mammatt (2009) even holds that "integrated sustainability reporting is more about management than reporting" and Painter-Morland (2006) has identified gaps for sustainability issues in companies such as managerial code development, which should be related more to a "corporation's CSR initiatives and reporting practices." This gap in promoting sustainability issues can also be confirmed from a long-term value creation perspective as put forward by Churet and Eccles (2014), who found a strong relationship between integrated reporting and ESG quality of management.

This link between the communicational aspects of reporting to external audiences such as stakeholders and regulators with internal managerial practices is also well described in the framework on sustainability accountability and reporting. Burritt and Schaltegger (2010) argue for both an inside-out and an outside-in perspective that interacts in what they call the "twin track approach." This perspective is also applied in this article to theoretically develop the concept of XBRL-based financial and non-financial reporting because it allows for application also from a management perspective. At the moment, however, following Eccles and Armbrester (2011), the link between integrated reporting and management practice is "embryonic" (14), which relates to T1 and the infancy of integrated reporting. At the same time, this embryonic state – positively put – opens space for future development in combining accounting, reporting, and management of corporate sustainability in an integrated and holistic manner.

In summary, the following trend statement is proposed:

T3: A considerable gap still exists in the integration of sustainability management and control with integrated reporting.

3.4. Trend 4: mandatory vs. voluntary: the unclear status and transformation of reporting standards and legal frameworks in a globalized world

The legal status of sustainability reporting is one of the most crucial questions, as reporting in the past was mostly associated with annual reports on financials for either the general public, including investors (Yan Peng et al., 2011; Tschopp and Huefner, 2014), or regulators such as the SEC (Lester, 2007; Srivastava and Kogan, 2010), the legal status of financial reporting was clearly determined. Regulators require specific information on business operations and performance (like the 10-k report for the SEC) and based on the report a license to operate is granted. Annual reports were seen as reports to investors and other stakeholders to inform in a favorable way about the corporate year. With sustainability reporting and associated with it the debate about social and environmental responsibilities of corporations, the line between mandatory reporting as understood from financial reports and voluntary reporting as understood from the early sustainability reports (for a longitudinal overview, see Gatti and Seele, 2014) became increasingly blurred.

This transitory status in scholarly research is dealt with in the debate on principle vs. rule based regulations, leading to paradoxes in overall regulation (Black, 2008), especially given differences in the legal system of the U.S and the E.U. (Burgemeestre et al., 2009). Particularly for a European context, principle based regulation causes problems with respect to interpretation and enforcement, as Black (2008) has pointed out. What matters for mandatory reporting also applies for voluntary reporting, and this would create even more severe paradoxes. Voluntary guidelines such as those from the non-governmental organization (NGO) Global Reporting Initiative (GRI) or local guidelines such as the Johannesburg Securities Exchange Socially Responsible Investment (JSE SRI) (Maubane et al., 2014) were created to provide standardization, comprehensiveness, and assurance. Furthermore, single countries started to make sustainability reports mandatory, including Denmark, Sweden, and Malaysia, and in April 2014 (to be applied into national legislation of the member states in 2017) the European Union made non-financial reporting mandatory for more than 5000 corporations (Howitt, 2014).

For corporations operating internationally and multinational corporations, the questions of whether to report non-financial information and to what degree and level of comprehensiveness remain unanswered and critics hold that sustainability reporting, to a certain extent, is meant only to present a more favorable perception of the company to public stakeholders. This phenomenon, referred to in the literature as the "CSR communication paradox," indicates that with more and more reports, skepticism and scrutiny of the public increases (Waddock and Goggins, 2011). Empirical evidence of this paradox has been reported by Cho and Roberts (2010). They show with a sample from the USA's Toxic 100 that inferior environmental performers provide more extensive disclosure in terms of content and website presentation.

Taking this criticism as a starting point, the call for reporting standards and legal frameworks is understandable, both for the company to receive guidance about what to disclose and what not to disclose and for the stakeholders, particularly investors, to assess the sustainability performance of a company. Yoon et al. (2011) argue in the same direction when promoting reductions in "information asymmetry" by suggesting the development of

standardized non-financial parameters for the capital market as well as standardized parameters by governments for business reporting.

The discussion about voluntary versus mandatory reporting of corporate sustainability has also been taken up by the United Nations Environment Program (UNEP, 2010), which developed a matrix with reasons for and against mandatory and voluntary approaches. As for the topic of this article, the most important reasons for mandatory reporting were the changing corporate culture, comparability, de facto non-disclosure of negative performance, and standardization or equal treatment of investors. However, reasons against mandatory reporting included the knowledge gap between regulators and industry, lack of incentive for innovation, and individual inappropriateness as "one size does not fit all" (also known as the materiality issue). For voluntary reporting, UNEP instead finds the following positive reasons: flexibility, proximity, and collective interest of industry. Against voluntary reporting are the following points: conflict of interest, inadequate sanctions, under-enforcement, and insufficient resources. UNEP aims to be neutral in its judgment and to only outline the reasons involved, however research based on empirical results such as that of Frias-Aceituno et al. (2013a) is forthright in demanding "national laws and protection mechanisms," otherwise transparency is at risk. Second, researchers postulate that "managers must be able to decide on the appropriate disclosure practices in the context of their own legal environment in order to obtain maximum benefits from their decisions" (Frias-Aceituno et al., 2013a: 228).

In summary, the following trend statement is proposed:

T4: The currently blurred line between voluntary and mandatory sustainability reporting creates conflicts of interest for companies leading to Greenwash-pitfalls and under-enforcement of progress in promoting sustainability and transparency.

4. Literature review on XBRL-based integrated reports

XBRL stands for eXtended Business Reporting Language and is used primarily in financial reporting. XBRL is an eXtensible Markup Language (XML)-based standard created to define and exchange business information, particularly used for reporting. Reports produced making use of an XBRL data base and taxonomy are called 'integrated reports' (not to be mixed up with integrated reporting as reviewed in chapter 3, hence they are referred to as XBRL-integrated reports). They are called 'integrated' because the data management and reporting are integrated into one common data repository in XBRL. Hence, data-migration errors and transaction costs are reduced (Burnett et al., 2006). In addition, managers have real-time access to the data repository and do not have to wait for the data to be proceeded and migrated. The same advantage applies for investor's information acquisition costs (Yan Peng et al., 2011). In addition to the efficiency of data management, XBRL also offers economic benefits for companies as well as regulators because a standardized digital taxonomy helps reduce costs in two ways (Arruñada, 2011). Firstly, by relying on a standardized data repository, companies do not have to obtain assurance from external accounting consultancies because the performance data is directly used to produce reports (Plumlee and Plumlee, 2008). Therefore, filers are not required to obtain third-party assurance on the XBRL instance document (Srivastava and Kogan, 2010). This reduces costs and the risks of data transferal errors. Second, XBRL enhances the value of disclosure through administrative reforms of filing, archiving, and retrieval systems that are more reliable because the data entry points of the taxonomy are based on the same standards for both companies and regulators. This, as developed in a research article by Alles and Piechocki (2012), helps improve overall corporate governance, as tagged data can be used to change the way in which decisions affecting governance are made.

4.1. Trend 5: XBRL working its way from financial to non-financial data management

So far, XBRL has been used for financial information to be reported in a standardized and digital manner to regulators such as the SEC, the Committee of European Banking Supervisors (CEBS), the UK's HM Revenue & Customs (HMRC), and India's Ministry of Corporate Affairs (MCA), to name a few (Sinnett, 2011). However, as Tschopp and Huefner (2014) point out, "some of the defining moments in the evolution of financial reporting have yet to take place in the development of CSR reporting" (x). Here, XBRL can play a crucial role in facilitating progress toward more comprehensive and rigorous sustainability reporting, although sustainability reporting based on XBRL may take a different evolutionary path than financial reporting due to the varying stakeholders involved. The deficiencies that separate non-financial reporting from financial reporting are "comparability, consistency, reliability, and relevance" (Tschopp and Huefner, 2014). Here, XBRL can bring improvements to sustainability reporting as it has to financial reporting.

The major advantages of XBRL in business reporting affect governance, transparency, data management, and cost effectiveness and also add economic value. Consequently, XBRL paves the road to develop different fields of application, also in sustainability reporting, benefiting from the opportunities in data management based on standardized XBRL taxonomies. However, it is more of an incremental than a quantum leap to extend the scope of XBRL-based financial reporting to sustainability reporting. First attempts and conceptualizations have already been proposed to develop XBRL-based sustainability metrics (Harris and Morsfield, 2012). A first application field in which to apply XBRL to reporting is the shift from financial reporting to the measurement and reporting of the energy performance of buildings, which opens the door for XBRL-based sustainability reporting. Gräning and Kienegger (2007), inspired by Basel II and financial reporting, suggest that XBRL can be used "as a mean of standardization for the reporting concerning the energy performance of buildings" and discuss the generalization of XBRL and the possibility of applying it to other domains. Another aspect has been described as "inter-organizational sustainability reporting" (Solsbach et al., 2014), which is harmonized by XBRL and brings comparability and standardization. Finally, GRI has developed one of the first XBRL taxonomies for sustainability reporting in collaboration with Deloitte to be applied in the new 4.0 guidelines (Knebel and Seele, 2015). GRI claims: "It will help investors, auditors and analysts to access information in sustainability reports faster, and more simply" (GRI, 2014).

In summary, the following trend statement is proposed:

T5: XBRL, as already established in mandatory financial reporting, offers opportunities to develop rigorous sustainability metrics that increase comparability and cost reduction.

4.2. Trend 6: XBRL reporting Fosters accuracy, reliability, and real-time reporting in sustainability reporting

In addition to the described advantages of XBRL-based business reporting, other criteria can be identified that will help in developing sustainability reporting to become more holistic with regard to both content and managerial application. Apart from the

standardization benefit, one other important advantage is in reducing information asymmetry. Blankespoor et al. (2014) identified this element as providing a level playing field for small investors, as well as for large, sophisticated investors. This also was one reason why the SEC mandated in 2009 that financial statements must be filed using XBRL (Kaya, 2014). Next to the cost benefits of not obtaining third-party assurance on the disclosure document, XBRL works as a concept incentive to enhance the financial reporting supply chain (Buys, 2008) and to involve major stakeholders in the use of XBRL-based reporting (Doolin and Troshani, 2004). This stakeholder engagement in digitally embedded internet financial reporting helped the diffusion of XBRL in the UK immensely as "it is easier for stakeholders to extract information directly into spreadsheets, or any other XBRL-enabled analysis software, without the need to re-key data thus providing significant improvements in information flows and enhancing inter-company comparability" (Dunne et al., 2013: 167).

This access to information for both members of the company and stakeholders also represents an important step forward with regard to the transparency of the data to be obtained. Furthermore, due to the standardization by a software-based data repository and taxonomy, the comparability for internal and external stakeholders as well as regulators is increased. This comparability hinders greenwashing and allows for rigorous assessment of sustainability performance and control for all parties involved. yyy.

As early as 2001, Debreceny and Gray described the subsequent effect of accuracy and reliability by the widespread adoption of XBRL for financial data. Hence, both "human and software agents could operate on financial information disseminated on the Web with a high degree of accuracy and reliability" (Debreceny and Gray, 2001: 47). An additional criterion for organizing progress by XBRL reporting was found by Richards and Tower (2004), who point at the technical possibility of "real-time reporting," as the data repositories would receive data directly from measuring instruments. Therefore, as indicated in the comparison table below, corporate executives as well as regulators and external stakeholders (if data were published instantly) could react immediately in making informed decisions on relevant data points (whether financial data or non-financial data). Therefore, Cohen (2004) emphasizes the potential for communicational processes of XBRL-based reporting, saying that XBRL does more than list data items. Instead, it is a "complete set of tools for regulators or groups to fully communicate the meanings of and interrelationships among the business reporting concepts" (Cohen, 2004: x). Given sustainability issues, the role of communicating meaning to different groups in a standardized and comparable manner is even more important because it allows for stakeholder involvement regardless of filtered information (theoretically). Because of the unifying potential of XBRL, it has been discussed as a possibility for developing a global reporting standard. This concept was a cooperation between XBRL and the International Financial Reporting Standards (IFRS) to establish a common ground for international firms and create a platform that would enhance the benefits of XBRL (Bonson et al., 2009). Next to the debate on global governance, this is of particular interest for multinational corporations unifying their data management within a global data standard. Hence, following Zhu and Wu (2011), XBRL improves the quality of financial data and the efficiency of the data supply chain in a networked business environment. As a next step, this characteristic can be extended to sustainability reporting.

In summary, the following trend statement is proposed:

T6: XBRL allows for more accurate and reliable data management and additionally opens the way to real-time reporting to internal and external stakeholders.

4.3. Trend 7: faster and better informed managerial decision-making for financial and non-financial data

The previous propositions address the transferability of XBRL to sustainability reporting and its technical advantages and contributions, such as accuracy, reliability, comparability, and a quantum leap in real-time-transparency in business reporting. The last point has additional consequences to be addressed here separately. Real-time transparency of XBRL data repositories and taxonomies bears consequences not only for the readers of reports, but also on an internal managerial level. Real-time monitoring of the data repository allows for instant performance measurement and control, which in return gives managers and executives the opportunity to make better informed decisions without delay. Regarding financial data, this allows for effective analytics, also relevant for shareholders. In a study of early XBRL adoption on analysts' forecast accuracy, Liu and O'Farrell (2013) report that streamlined information sharing in the value chain is considered the leading issue and that XBRL plays a critical role in an increasingly networked environment making use of e-business.

For managers, XBRL also has positive implications in organizing business intelligence, particularly affecting standardization and rationalization with regard to financial data (Schwalm and Bange, 2004). This shows that XBRL-based financial statement information not only has an effect on investors (Efendi et al., 2014), but also – following Hodge et al. (2004) – managers' choices for reporting the available information. Cohen (2004) suggests that XBRL is a unique customization capability and "customizable standard" that also offers new opportunities for sustainability reporting as developed in this article. Among these opportunities is the "readability and re-usability" of data and the elimination of tagging work, as all data are managed in one taxonomic data repository. This contributes to "transparency and accessibility" of corporate data (Bhatnagar, 2011; Premuroso and Bhattacharya, 2008), which also allows a change of perspective. Williams et al. (2006) suggest adopting an "information management perspective" that goes beyond the mere reproduction and presentation of data and involves an active management perspective inside the corporation.

Empirical evidence on the use of XBRL is presented by Kaya (2014). Results show that a company's innovativeness is positively related to the extent of overall disclosures, including the voluntary disclosure in XBRL. Given this positive effect of voluntary XBRL reporting on innovativeness, it becomes understandable that authors expect XBRL to "develop into the global data standard for business financial reporting with the potential to change the way that decisions are made" (Liu et al., 2014). Therefore, the managerial implications of XBRL become evident and provide additional capacity to managerial decision-making processes.

In summary, the following trend statement is proposed:

T7: XBRL adds value for managers because it leads to better informed and faster (real-time data-based) decision making with respect to financial and non-financial issues.

4.4. Trend 8: standardization and regulation as facilitators of sustainable societies

The final and possibly most powerful trend regarding XBRL involves its potential to promote sustainable societies via the technical opportunities obtainable by XBRL-based data management for financial and non-financial data. In conjunction with the ongoing trend in making sustainability reporting a mandatory

exercise for corporations, as already done in Denmark, Sweden, and Malaysia, and as planned in Korea (Jeong et al., 2013) and the European Union (Howitt, 2014), the political will toward sustainability reporting is gaining momentum. This in return changes the very essence of business reporting in response to regulatory and market demands (Cohen, 2004). These new political realities or societal engagements through civil society (Kourula and Delalieux, 2014) also gave rise to the question of standardization because inconsistent and non-comparable sustainability reports were the status quo before the GRI and its reporting guidelines (Burritt and Schaltegger, 2010: 840). As mentioned above, in 2013 when releasing the new 4.0 guidelines, GRI developed an XBRL taxonomy for non-financial parameters. This is the last step of an ongoing movement toward standardized electronic filings that started with requests from regulators, and such filings are rapidly becoming mandatory in many countries (Cohen, 2004).

From a government point of view, XBRL as a standard for electronic filings helps to "increase accountability and transparency in business and financial information" because it is machine-readable and interoperable, thereby "improving the ease of public dissemination and analysis" (Chen, 2012: 553). However, governments not only promote XBRL for transparency and sustainability reasons but also for cost-efficiency: "business-to-government information exchange is a next frontier for reducing government spending while improving performance" (Bharosa et al., 2013: 9). Hence, the promotion of interoperable data is a driving force in developing the future of software-based reporting. Given this technical possibility of increased accuracy, comparability, and real-time transparency, one can argue that the application and extension of XBRL to sustainability reporting as initiated by the latest GRI guidelines is a major force in promoting corporate sustainability. Given the critique of sustainability reporting mentioned above and the impact of successful sustainability management systems and performance in corporations on a managerial level, it becomes evident that sustainability reporting should reach the same level of seriousness and credibility as rigorous management and accounting systems. Therefore, standardization is a key contributor to sustainability in society via corporate sustainability. As Debreceny et al. (2010) argue, the quality of the XBRL data repositories is vital for the success of interactive data programs (2010: 296). Therefore, the role of regulators cannot be overestimated. Some authors also argue that successful diffusion of XBRL is at risk without greater regulatory commitment to creating tools and making "publicly available, accessible, repositories of XBRL data" (Dunne et al., 2013: 167). In a landmark paper, Eccles and Armbrester conclude that more sustainable company strategies will contribute to a more sustainable society (2011: 14).

In summary, the following trend statement is proposed:

> *T8: Rigorous XBRL taxonomies for sustainability data and related regulatory commitment facilitate an improved contribution to the overall sustainability of societies.*

5. Digitally unified reporting as a "twin track approach" providing a new time-ontology

Based on the eight trend statements on integrated reporting and XBRL from the scholarly literature, I propose the concept of "digitally unified reporting," incorporating the eight trend statements aiming at closing the sustainability gap addressed in the introduction. The concept, however, is developed not only on the grounds of the trend statements, but also positioned theoretically (chapter 5.1). Here I use the Burritt and Schaltegger (2010) sustainability reporting typology and position the new concept as a "twin track" approach (see below). In the second step, I examine the new concept regarding the shift it represents in merging reporting with performance control. I discuss in a second step (chapter 5.2) what I refer to as "time-ontological shift" brought about by digitally unified reporting, as the reporting period changes from ex-post to real-time transparency. To conclude, I bring together the trend statements with the theoretical positioning and discussion of the time-ontological shift by providing a definition of digitally unified reporting plus an application context.

5.1. Digitally unified reporting: conceptual development as a twin track approach

The rapid changes in the evolution of sustainability management and reporting have also been discussed on a theoretical level. For the topic discussed here, the "twin track approach" of sustainability reporting appears to be the most suitable. Following Burritt and Schaltegger (2010), the twin track approach combines both inside-out and outside-in perspectives (also see Schaltegger and Wagner, 2006) of sustainability reporting. This is particularly important as, in line with the concept proposed here, the twin track approach combines a management perspective (inside-out) with a stakeholder perspective (outside-in) based on the evidence that sustainability management systems have a major influence on sustainability accounting and reporting (Burritt and Schaltegger, 2010: 841). The theory of the twin track approach builds on (2010) approach for using data in ESG contexts. This – enriched by the technical specificities of XBRL – is an important feature in combining sustainability performance and reporting to monitor compliance with environmental regulation, motivate continuous improvement, provide data for internal decision making, and finally provide data for external reporting (Burritt and Schaltegger, 2010: 842).

Based on the theoretical grounding of the twin track approach, I define "digitally unified reporting" (DUR) as follows.

> DUR is a reporting and performance measurement concept that builds on a common standardized real-time data repository in XBRL for financial as well as non-financial data. DUR combines XBRL based *integrated reports* (reporting and management access the same real-time data repository in a markup language such as XBRL) and *integrated reporting* (financial and nonfinancial data integrated in a single report) to arrive at a reporting and performance measurement format simultaneously communicating inside-out and outside-in and provides opportunities to involve external stakeholders and regulators. DUR represents a time-ontological shift from ex-post reporting to real-time 24/7/365 transparency (also allowing for real-time regulatory activities).

Based on the theoretical positioning and presentation of the technicality of digitally unified reporting, one might ask about the difference between XBRL-enriched integrated reporting and digitally unified reporting. Here the potential for unification is of major importance because digitally unified reporting brings about a transformation via a unification process occurring on two levels:

> *Unification I:* Technical unification by using a common data repository for both financial and non-financial data. This, as described in T6, allows for higher accuracy and reliability, whereas a simply enriched XBRL-integrated report would just make use of data management.
> *Unification II.* Operational unification by merging management tasks as performance controls with corporate reporting and

accounting. Here, the common data repository allows instant access to all relevant data points regarding financial and non-financial issues and thus, as described in T7, faster and better decision-making processes are enabled.

Based on these considerations, the key parameters of digitally unified reporting are presented along the four trend statements derived from the literature review. This incremental approach is meant to increase construct validity of the concept, developing it from the state of the art in scholarly debate. An overview of the single contribution developed in response to each of the eight trends is presented in Table 1.

Hence, the concept of digitally unified reporting and performance control contributes to close major gaps in the literature concerning integrated reporting. Furthermore, going back to the debate on principles vs. rule based regulation the proposed concept would be positioned due to its digitally precise coding as a rule based approach, as every indicator would be referenced to a specific data point in the XBRL repository. This however opens questions on the 'materiality' of the data points.

The main contribution as developed in the eight criteria, however, can be seen in a time-ontological shift. Digitally unified reporting and performance control through XBRL-based real-time transparency allows for instant control of the standardized data. This has implications for the following:

a. *Managers*, as managers can control in real-time their sustainability and financial performance by measuring it in a GRI-inspired XBRL data taxonomy and repository. This contributes to the claimed combination of management control, strategy, and sustainability (Crutzen and Herzig, 2013).
b. *Regulators*, as regulators technically could monitor harmful and unsustainable corporate performance in real time and could – provided the according legislative power – withdraw the license to operate of a corporation that is performing in a toxic manner with regard to ESG criteria.
c. *Investors*, as an XBRL data repository, also including sustainability data would allow for standardized and comparable information. Sustainability reporting in an integrated manner, as proposed in digitally unified reporting, would allow shareholders and analysts to assess sustainability performance by interoperable databases as technically available by XBRL data repositories.
d. *External stakeholders*, like media or NGOs that can also monitor in real-time the sustainability performance of corporations. Here, both the time lag and the information asymmetry could be

Table 1
Summary table: toward digitally unified reporting and performance control.

	Derived trend	… Digitally unified reporting and what it contributes
Integrated reporting	*T1: infancy and major trend* (Tilley, 2012; Ioannou and Serafeim, 2011; Eccles and Krzus, 2010; Soyka, 2013; Tschopp and Huefner, 2014)	DUR takes up the major trend of holistic integrated reporting in a single disclosure document. By an underlying XBRL data repository of financial and non-financial data, integrated reporting can be pushed toward new boundaries.
	T2: the promise of more 'holistic transparency' and gap between companies and investors (Adams and Simnett, 2011; Bharosa et al., 2013; Chen, 2012; Lubin and Esty, 2014; Wild and van Staden, 2013; Kolk, 2004; Beattie and Smith, 2013; Leuner, 2012; Gurvitsh and Sidorova, 2012)	DUR making use of XBRL-based standardized data for financial and non-financial data helps in achieving comparability to stimulate technical advancement for regulators toward a more rigorous promotion of sustainability.
	T3: gap in the integration of sustainability management and control with integrated reporting (Mammatt, 2009; Painter-Morland, 2006; Churet and Eccles, 2014; Burritt and Schaltegger, 2010)	XBRL-based integrated reporting, understood here as DUR, helps in fulfilling the promise of integrated reporting, as companies, investors, regulators, and other stakeholders get an interoperable, machine-readable database which helps in making better informed and comparability-based decisions.
	T4: conflict of interest and under-enforcement by unclear regulatory status (Yan Peng et al., 2011; Lester, 2007; Srivastava and Kogan, 2010; Gatti and Seele, 2014; Maubane et al., 2014; Howitt, 2014; Waddock and Goggins, 2011; Frías-Aceituno et al., 2013a)	When developed on a mutually agreed taxonomy of financial and non-financial values, DUR provides a sustainability performance measurement application that can be fully integrated into sustainability management tasks. Due to real-time transparency, it also allows managers and regulators to arrive at decisions instantly as XBRL allows for instant monitoring of data, also on the internet.
XBRL-based integrated reports	*T5: XBRL offers opportunities to develop rigorous sustainability metrics* (Sinnett, 2011; Tschopp and Huefner, 2014; Yan Peng et al., 2011; Arruñada, 2011; Srivastava and Kogan, 2010; Alles and Piechocki, 2012; Knebel and Seele, 2015)	DUR builds on the established and partly mandatory data filing standard of XBRL for financial data. As first attempts by GRI have been undertaken to produce an XBRL sustainability taxonomy, DUR can increase comparability and transparency and also reduce costs for regulators, analysts, and companies in organizing data and managing sustainability.
	T6: more accurate and reliable data management and real-time reporting (Blankespoor et al., 2014; Kaya, 2014; Buys, 2008; Dunne et al., 2013; Debreceny and Gray, 2010; Cohen, 2004; Zhu and Wu, 2011)	In addition to accuracy, reliability, and cost-efficiency, one of the most important advancements of DUR is real-time transparency for managers as well as regulators and other stakeholders. Thus, it lifts the twin track approach of reporting to a new level, as no two tracks are managed at the same time, but two tracks build on the same unified and standardized data repository.
	T7: faster and better informed managerial decision-making processes (Liu et al., 2014; Schwalm and Bange, 2004; Efendi et al., 2014; Hodge et al., 2004; Bhatnagar, 2011; Williams et al., 2006; Kaya, 2014)	On a managerial level, DUR allows for wide-ranging sustainability performance measurement and control as all data are stored according to a predefined XBRL taxonomy in company-specific and customized data repositories that can also be used for inside-out reporting in real time. The economic benefit as confirmed for financial data and reporting also can be utilized for sustainability management and reporting.
	T8: contribution to the overall sustainability of societies. (Jeong et al., 2013; Burritt and Schaltegger, 2010; Howitt, 2014; Eccles and Armbrester, 2011; Dunne et al., 2013)	On a holistic level comprising economic, environmental, and social benefits, DUR allows for a stronger contribution to the overall sustainability of societies because it provides integrated data for financial and sustainability issues that can be standardized and compared easily by internal and external stakeholders.

overcome and stakeholder dialogues would take place in a more deliberative way, as proposed by Habermasian political CSR communication (Seele and Lock, 2014).

Given this integration between internal performance and reporting systems and external reporting audiences, progress toward more sustainable societies by increased levels of transparency and thus credibility can be achieved. The major contribution here is the effect of continuous real-time transparency that I call 24/7/365 transparency. To sum up, the core features of digitally unified reporting and performance measurement can be seen in:

- 24/7/365 transparency to regulators for financial and sustainability data
- 24/7/365 transparency to stakeholders for financial and sustainability data, which bridges the credibility gap (Dando and Swift, 2003) of conventional sustainability reporting
- Instant access to real-time sustainability data, allowing for real-time control over sustainability performance
- Real-time control over sustainability performance, allowing for application of real-time sustainability management systems
- Standardized data entry points of XBRL, allowing for rigorous and comprehensive standardization and assessment of sustainability performance and reporting
- Standardized data points in the sustainability universe, providing a level playing field and ending the flaws of the materiality concept of GRI

Linking the concept of digitally unified reporting to the twin track approach of reporting, one can conclude that digitally unified reporting and performance measurement contributes to the overall promotion of more sustainable societies and to closing the sustainability-gap, as it increases the compliance and efficiency of sustainability reporting and performance control. This is particularly true for deliberative actions based on accounting information and management performance, as demanded in the twin track approach when integrating approaches like the sustainability balanced scorecard, eco-control, or sustainability management control (Burritt and Schaltegger, 2010: 833).

Therefore, XBRL-based digitally unified reporting represents one small step in the digital evolution, but it is a leap for corporate sustainability performance measurement and reporting because it transcends the time ontology from past performance output to real-time 24/7/365 transparency, as the comparison between conventional reporting and XBRL-based digitally unified reporting in the next chapter shows.

5.2. Comparing current integrated reporting with digitally unified reporting: the time-ontological -shift

Unlike conventional corporate reporting with external sustainability performance measurement and control and management instruments, XBRL real-time data of financial and sustainability performance allow for simultaneous management and publication of the data produced by operations. This – if applied rigorously and comprehensively – has considerable consequences for the way corporations are run and how they communicate to their stakeholders and authorities. To clarify this leap in the evolution from separate sustainability performance measurement, management, and settlement-day publication of the previous corporate year, a comparison is shown in Table 2.

Whereas in conventional reporting – whether stand-alone reporting or integrated reporting – time is subdivided according to operational steps: operations within a corporate year (t1), a period to gather and process the data from the previous year (t2), and a publication date in spring/summer of the following year (t3). Digitally unified reporting knows no temporal sequences but is constituted by a real-time flow of events (operations, production) and publication thereof.

What is true for the time frame also applies for the operational level. In conventional reporting, performance measurement, control and reporting are sequential and often produce mistakes in the migration of data from unit to unit or to the assurance provider. However, 24/7/365 digitally unified reporting provides full transparency by centralizing all data within the 20,000 data entry points of XBRL, which can be published or conveyed to authorities in real time.

This shift of data management and access also has implications for corporate departments. Whereas in conventional reporting the responsibility lies with different units in t1–3, in digitally unified reporting data management officers and executive members attract more responsibilities. Therefore, CSR and corporate communication departments might lose responsibilities as the administration of data now becomes centralized (see Table 3).

The comparison shows that the theoretical concept of digitally unified reporting and performance measurement allows for a new era in the advancement of sustainable companies on an organizational level. This shift is not founded in normative claims, but in combining technological advancements brought about by the technological opportunities of digital data management and the increasing political will to promote and govern sustainability issues by mandatory sustainability reports. This theoretical concept, however, is far from being reality, on technical grounds as well as on regulatory grounds, as the concept will only work if a transnational XBRL taxonomy for sustainability issues is developed (Eccles and Armbrester, 2011: 19). Therefore, it is of vital importance to address current limitations to develop the concept further.

6. Outlook

6.1. Contribution to the literature and limitations

When looking at corporate practices concerning sustainability performance measurement, control, and reporting, one might say that digitally unified reporting is a small step in the digital evolution, but a leap for corporate performance measurement and reporting.

This quantum leap is due to the digital revolution: XBRL as part of big data, incorporates and adds to the existing concepts and theories. Hence, digitally unified reporting contributes to the literature in many ways. Given the transformations the digital age imposes on corporations, governments, sustainability and society at large, the potential of digitally unified reporting and performance measuring to contribute to the according literatures is high. Where data science and big data found their way into management and particularly marketing research, sustainability science and theory is only at its beginning (Seele, 2015; Seele and Lock, 2015). Also, accounting, given the aforementioned time-ontological shift will be affected by the digital revolution. The literature on XBRL as reviewed above (chapter 4) shows that digital data is crucial to accounting, but at the same time theoretical advancement given the ontological and epistemological consequences are yet to come. Hence, the proposed concept can be seen as a threshold to new empirical and theoretical advancement of corporate reporting, performance measurement and management. Having said this, there are some limitations of the concept covering technical as well as governance issues. In sum, I discuss the limiting aspects of (too much) corporate transparency, global governance, and standardization, technical complexity, limits of supervising authorities,

Table 2
Time ontology of conventional, past-performance-driven reporting.

	Criteria/time horizon	t1:	t2: (1.1.–31.3)	t3: Publication of report(s)
Integrated reporting	Time frame	Corporate year n (1.1.–31.12)	Winter/spring (1.1.–31.3)	Publication of report(s) spring/summer year n + 1
	Operational level	Operations throughout the year (supply chain, marketing, operations)	Collecting and processing data; data management	Recipients: authorities, regulators, stakeholders, public eye
	Responsible unit	COO	CFO, Assurance provider	Corporate communication
	Performing unit	Production, employees	Sustainability manager, corporate communication	–

Table 3
Time ontology of XBRL-based digitally unified reporting constituting real-time transparency.

	Criteria/time horizon	t, (ongoing performance and reporting continuum):
Digitally unified reporting and performance measurement	Time frame	24/7/365 Data production AND simultaneous publication throughout the year
	Operational level	Sustainability operations (supply chain, marketing, operations) Data management Authorities, regulators, stakeholders, public eye
	Responsible unit	COO, CFO Data management
	Performing unit	Production employees, sustainability manager, corporate communication

quality of taxonomies, vulnerability of protected data, regulatory commitment, and development costs.

(Too much) corporate transparency is of concern. One strength of the concept is the new epoch of total 24/7/365 corporate transparency. There undoubtedly is an advantage to transparency as it prevents adverse behavior and provides a level playing field. On the other side, one might say that a limitation of this concept is in the vulnerability of corporate performance to outsiders. If reporting is not an information-filtering process anymore (which sustainability reporting has been criticized for with regard to the "credibility gap") but a transparent lens providing insight into all operations, one might also question the positive impact of the technology. Particularly, questions may arise with regard to business intelligence and espionage between corporations or between economies addressing the issue of patents and copyright protection.

Therefore, a macro-level limitation is the question of *global governance and standardization*. As long as single players like multinational corporations or economies free-ride on regulatory gaps, those companies and economies that do follow a rigorous transparency approach face a disadvantage, similar to the phenomena around carbon emission regulations and alternative energy policies.

Technically, a limitation is the complexity of XBRL standardized data repositories; 20,000 standardized data points create a complexity that covers many more aspects than, for example, the 56 key performance indicators of GRI 3.1. The complexity, in turn, opens the question of materiality in reporting. XBRL in a digital age (Seele and Lock, 2015) replicates similar topics and challenges to sustainability reporting as the raw data world of current sustainability performance that later is translated into reported data. Therefore, a committed approach to creating a feasible standard should reduce the complexity to a level where the measured performance and reporting data allow for comparability without compromising materiality issues.

Supervising authority involves an open question of who would supervise and control the correct measurement of data points. This could be accomplished via a certified sustainability management system or a public authority based on a regulatory framework. At the same time, if governed by national legislation, the topic of what can be called sustainability loopholes arises and relocation processes can be organized around possible loopholes and regulatory gaps.

If digitally unified reporting and measurement control were implemented in companies, this would transform, as indicated in chapter 5.2, processes and routines within organizations. For some departments, this could indeed mean a shockwave challenging the very existence of, for example, communication departments that might become mere publication design departments relying on data from the XBRL data repositories. Whereas, accounting departments might gain power by administering the data taxonomy and repository. The same could be true for chief financial officers (CFO) and chief operating officers (COOs) in monitoring and controlling financial and non-financial performance of, for example, the supply chain (Seuring and Müller, 2008) directly accessing the XBRL database.

Shortcomings of XBRL taxonomy quality are addressed by Arnold et al. (2012), who report evidence for taxonomy limitations in SEC-compliant XBRL reporting; this can also be expected in sustainability reporting. As the nature of sustainability reporting is even less standardized and also comprises such fuzzy topics as social sustainability and human rights, limitations of the XBRL taxonomy can be expected. Here, too little experience exists from current sustainability XBRL taxonomies, such as for GRI 4.0, to draw conclusions about the impact of taxonomy limitations. Also, Debreceny et al. find that the quality of the XBRL data is vital for the success of interoperable data programs. A key aspect they report is the "correctness of the mathematical relationships implied by the taxonomy and implemented in the instance document" (Debreceny et al., 2010: 296).

Vulnerability of protected data is also addressed. Like any digital data relying on network and internet connections, XBRL data are vulnerable to security threats. As Boritz and No (2005) state, XBRL services are subject to the insecurity of digital data. They conclude that XBRL services without good security measurements will not reach their full potential. As mentioned above, corporate intelligence and espionage can benefit from or create data leaks revealing confidential data on operations or even patents.

Regulatory commitment is needed to fully utilize the benefits of tagged data. Dunne et al. (2013) state that regulatory commitment is crucial for the success of XBRL-based reporting. They fear that XBRL might "vanish" if governments do not create "an impetus for XBRL such as creating tools and making publicly available, accessible, repositories of XBRL data" (Dunne et al., 2013: 167). The same is true for sustainability data. Given, for example, the European

Union law for mandatory non-financial reports, one can say that the commitment to standardize and govern sustainable development via mandatory reporting only exists so far on a formal level. Taking into consideration how and what needs to be reported, the application to govern sustainability issues is not yet developed. XBRL-based reporting standards may help organize comprehensiveness but without regulatory commitment the technology will not gain critical mass.

Another limitation lies in the realization that XBRL-based sustainability control and reporting can be seen in the *high costs of developing data standards*. Zhu and Wu (2014) discuss this point regarding financial data using XBRL repositories and it also applies to non-financial data. Once a standard is created and mandatory for all in an industry or legal system, the high setup costs are compensated by benefits from economies of scale for both companies and regulators. As an example, the SEC XBRL filing for control and comparability is much easier for regulators and the setup of XBRL carries no competitive disadvantage if all companies face it. This would be an important step in the advancement of XBRL-based sustainability data taxonomies and repositories.

As an overall limitation, the theoretical nature of the proposed concept can be mentioned. The concept proposed here is derived from scholarly literature. The claims made by academics do not necessarily represent the needs of the corporate world, the governance sphere, or regulatory affairs. What might appear functional in technical terms could also lead to a kind of sustainability regime, particularly if the proclaimed 24/7/365 instant transparency is combined with regulatory power and public authority.

6.2. Future research and conclusion

Given the transformative potential incorporated in the concept of digitally unified reporting, the next steps are crucial to bring to bear the innovations from the digital age as applied to sustainability reporting and management. Hence, the next step is to operationalize the research and produce empirical results. Therefore, I suggest the following design for future research. In a first phase, a series of rigorous case studies needs to explore the current status quo of corporate practice regarding sustainability reporting, XBRL implementation, and performance measurement. Here a comparative case study design seems appropriate. A second series of case studies should be conducted to analyze the regulatory framework of sustainability reporting given that sustainability reporting is now mandatory in several countries, but still voluntary in most. In a next step, research questions and testable hypotheses should be developed based on the literature and the results of the case studies regarding corporate practice and shifting regulatory baselines. The future research building on the conceptual paper, the two sets of case studies, and the hypothesis development should address empirical validation. Here an experimental research design is suggested because the topic involves future transformations, so manipulations in a vignette-based experimental setting seem appropriate to evaluate the actual trade-off in the concept proposed. Overall, a series of five or six experiments should manipulate different factors regarding the digitalization and legal status of reporting to arrive at a validation of the feasibility and benefit of the concept.

In conclusion, the introduction of more rigorous reporting and accounting data and standards is no substitute for integrity. Corporations that voluntarily engage in the promotion of sustainability issues might become discouraged from continuing in a first-mover position when an overall standard is introduced. Next to integrity, digitally unified reporting also offers new ways of advancing mandated or legally binding sustainability. Given, for example, the progress in making CSR-reporting mandatory in the EU, a standardized data repository offers – as in financial reporting to authorities – new ways of creating a level playing field by regulating authorities for organizations, once the materiality issue is settled. Here, the SEC as applied for financial data could be seen as a benchmark to develop a framework also for non-financial data.

Moreover, the commitment to sustainability might become a mere tick-a-box exercise in administering the XBRL sustainability data repository and the power to innovate in sustainability might be substituted by only fulfilling regulatory requirements. Lester (2007) points to the XBRL standards of the SEC, which could improve reporting and accountability, but nevertheless suggests that students of business still require training in integrity and business ethics with regard to accounting scandals. The same applies to sustainability.

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