Environmental Performance Disclosure in the CSR Reports of Construction Companies

A. S. Chang, Z. Y. Li, and Y. L. Chen

Abstract—**More and more companies are publishing CSR reports in the past 20 years. However, the environmental performance information is usually not sufficiently disclosed by many companies. It is worth to examine and analyze the content of the indicators in the CSR reports.**

This research investigated the disclosure of the environmental indicators in the CSR reports of eight construction-related companies compiled based on the GRI guidelines. The GRI indicators were first classified into qualitative or quantitative as well as environmental impact or mitigation initiative types. These actual indicators in the CSR reports were examined to analyze their disclosure percentages and finally ranked in three levels to indicate the disclosure sequence for construction companies.

The findings show that the 30 GRI indicators are quantitative in which 18 are also qualitative; and 28 indicators address environmental impacts and 8 address mitigation initiatives. The average disclosure rate of the 30 indicators is 53% and the numbers of high, medium and low disclosure indicators are 10, 8 and 12 respectively. A company can disclose with priority the quantitative indicators of the high disclosure level such as energy, water, and GHG emissions, supplemented by qualitative ones such as the products and services. The material data should be collected and disclosed early to make the resource consumption more transparent.

Index Terms—**Construction company, corporate social responsibility, environmental indicators, GRI guidelines.**

I. Introduction

The publication of CSR (corporate social responsibility) reports has been the norm, not only the exception for large companies in the world [1]. Industries with relatively high multi-stakeholders involvement such as oil and gas, utilities, and automotive sectors have initiated to publish CSR reports since late 1980s [2]. However, the CSR reports did not describe the key impacts on the environment and society [3].

Studies indicated the insufficiency of CSR reporting, such as disclosure not in a systematic method, disclosure standards not met, quantitative data not accompanied with qualitative description, sustainable performance not measured and predicted, etc. [4]-[6]. The disclosure of environmental indicators in the CSR reports of 16 large companies in Greece was only 13% on average [7]. In the construction industry, the annual reports of 42 companies in the UK were reviewed and found that little information related to sustainability was disclosed, and relatively few large companies changed their business paradigm [8].

This study investigated the disclosure of the 30 environmental indicators in the CSR reports of eight construction-related companies compiled based on the GRI (Global Reporting Initiative) G3.1 guidelines. It analyzed the environmental indicators and practices reported in the CSR reports, evaluated the content and degree of indicator disclosure, and suggested the sequence of disclosing environmental indicators for the construction industry. GRI approached forty percent of all CSR reports worldwide [9].

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II. Research Methodology

The CSR reporting needs guidelines to provide suggestions for business operational activities and encourage enterprises' contributions to sustainability development [10]. The GRI provides guidelines for companies to disclose their CSR reports and has been used most frequently for sustainability reporting [11]. One major part defines the standard disclosures and compilation of performance indicators in economic, environmental, and social categories [12]. The environmental performance covers nine aspects of indicators including materials; energy; water; biodiversity; emissions, effluents and waste; products and services; compliance; transport; and overall. There are 30 environmental indicators, labeled EN1 to EN30, such as materials used by weight or volume (EN1), direct energy consumption by primary energy source (EN3), etc.

This study adopted the content analysis and case study methods. First, the GRI guidelines especially the reference and compilation requirements for each indicator were analyzed to distinguish the 30 indicators into qualitative or quantitative as well as environmental impact or mitigation initiative types. Eight of the 16 listed international companies were selected as cases to study their indicator disclosure in their CSR reports [13]. The percentages of indicators disclosed by the eight companies were calculated and the indicators were ranked in high, medium, and low levels accordingly. Finally, the indicators were prioritized to suggest a meaningful sequence for disclosure.

The data of the eight companies are shown in Table I, including four constructors (C1~C4), two developers (D1 and D2), and two material suppliers (M1 and M2) of different countries. Their annual revenues were large with some different products and services. Six of the eight companies were founded more than 100 years ago. They first published relevant reports from year1997 to 2007. Their CSR reports of year 2009 or 2010 were reviewed and the websites accessed are shown in the references [14]-[21].

III. Indicator Disclosure Analysis

In this section, the measurement scale method was used first to classify the 30 GRI indicators into diffeent types. Then the 30 indicators of the eight companies were

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examined to evaluate their disclosure. The disclosure rates were calculated to rank the indicators in high, medium and low levels.

A. Measurement Scales and Types of Indicators

The measurement scale has to be understood when analyzing the required indicator data. Stevens [22] used measurement theory to analyze the mathematical characteristics of data and established four scales of measurement. The four scales are still used after some refinement of definitions [23]: (1) nominal scale such as male and female, (2) ordinal scale such as large, medium and small, (3) interval scale such as 1, 2, and 3, and (4) ratio such as percentage. The nominal and ordinal scales are basic qualitative measurement that is easier to use. Internal and ratio scales are quantitative measurement that needs numbers sometimes not available. From analyzing the reference and compilation of the 30 indicators in the GRI guidelines, the indicators, their GRI aspects, the measurement scales and types are shown in Table II. The indicators are denoted with the four scales by 1, 2, 3 and/or 4. For example, EN1 is the materials used by weight or volume. It is a quantity as the interval scale indicates so is denoted as 3; EN6 is the initiatives to provide energy-efficient or renewable energy based on products and services, and reductions in energy requirements. Its compilation requires (1) reporting initiatives to reduce energy and (2) quantified reductions, which correspond to scales 1 and 3. So EN6 is denoted with scales 1 and 3 as well as quantitative and qualitative measurements.

The last two columns in Table II describe the indicators that either measure environmental impacts caused and/or explain mitigation initiatives by a company. For example, EN1 calculates the material consumption, a kind of environmental impacts, to address global resource conservation; EN6 evaluates both environmental impacts (from reduced energy) and mitigation initiatives (from the adopted initiatives). EN 14 of strategies, current actions, and future plans for managing impacts on biodiversity mainly addresses mitigation initiatives. But the GRI compilation also asks for setting specific targets and monitoring processes that are related to environmental impacts.

TABLE I: DATA OF EIGHT CASE COMPANIES

Profile Firms	Country	Annual Revenue (billion)	Products and Services	Year Founded	First report (Year)	Report reviewed Year	Report reviewed Name
C1 Hochtief	Germany	12.1 (Eur)	Buildings, airports, project management	1874	2001	2009	Sustainability Report
C2 Obayashi	Japan	14.4 (USD)	Construction, property management	1892	2007	2010	CSR Report
C3 Fluor HSE	USA	21.9 (USD)	Construction, Procurement, maintenance	1912	2006	2009	Sustainability Report
C4 Group Five	South Africa	113.3 (ZAR)	Construction, material manufacture	1974	2005	2009	Annual Report
D1 Stockland	Australia	13.4 (USD)	Real estate, retired life	1952	2004	2010	Corporate Responsibility & Sustainability
D2 Swire Properties	Hong Kong	249.0 (HKD)	Real estate, aerospace, trade, sea transport	1816	2003	2009	Sustainable Development Report
M1 Holcim	Switzer-land	216.5 (Franc)	Cement, aggregates, other materials	1912	2002	2009	Corporate Sustainable Development
M2 CEMEX	Mexico	14.0 (USD)	Cement, aggregates, trade	1906	1997	2009	Sustainable Development

TABLE II: MEASUREMENT SCALES AND TYPES OF 30 INDICATORS

GRI Aspects/Indicators		Scale	Quanti-tative.	Quali-t ative	Im-pact	Initia-tive
Materials						
EN1	Materials used by weight or volume	3	✔		✔	
EN2	Percentage of recycled materials used	4	✔		✔	
Energy						
EN3	Direct energy consumption	3	✔		✔	
EN4	Indirect energy consumption	3	✔		✔	
EN5	Energy saved due to conservation and efficiency improvements	3	✔		✔	
EN6	Initiatives to provide energy-efficient or renewable energy based on products and services, and reductions in energy requirements	1,3	✔	✔	✔	✔
EN7	Initiatives to reduce indirect energy consumption and reductions achieved	1,3	✔	✔	✔	✔
Water						
EN8	Total water withdrawal by source	3	✔		✔	
EN9	Water sources significantly affected by withdrawal of water	1,3	✔	✔	✔	
EN10	Percentage and total volume of water recycled and reused	3,4	✔		✔	
Biodiversity						
EN11	Potential impacts of location of land in or adjacent to protected areas	1~3	✔	✔	✔	
EN12	Significant impacts of activities, products, and services	1~4	✔	✔	✔	
EN13	Habitats protected or restored	1~3	✔	✔	✔	✔
EN14	Strategies, current actions, and future plans for managing impacts on biodiversity	1~4	✔	✔	✔	✔
EN15	No. of species with habitats in areas affected by operation, by level of extinction risk	1~3	✔	✔	✔	
Emissions, Effluents, and Waste						
EN16	Total direct and indirect GHG emissions by weight	3	✔		✔	
EN17	Other relevant indirect GHG emissions by weight	3	✔		✔	
EN18	Initiatives to reduce GHG emissions and reduction achieved	1,3	✔	✔	✔	✔

GRI Aspects/Indicators		Scale	Quanti-tative.	Quali-tative	Im-pact	Initia-tive
EN19	Emissions of ozone-depleting substances by weight	3	✔		✔	
EN20	SOX、NOX, and other significant air emissions by type and weight	1,3	✔	✔	✔	
EN21	Total water discharge by quality and destination	1,3	✔	✔	✔	
EN22	Total weight of waste by type and disposal method	1,3	✔	✔	✔	
EN23	Total number and volume of significant spills	1,3	✔	✔	✔	
EN24	Weight of transported and treated hazardous waste	3	✔		✔	
EN25	Water bodies and related habitats significantly affected by the discharge of water and runoff	1~3	✔	✔	✔	
Products and Services						
EN26	Initiatives to mitigate environmental impacts of products and services, and extent of impact mitigation	1~4	✔	✔	✔	✔
EN27	Percentage of products sold and their packaging materials that are reclaimed	4	✔		✔	
Compliance						
EN28	Monetary values of significant fines and total number of non-monetary sanctions	1,3	✔	✔		✔
Transport						
EN29	Significant environmental impacts of transporting products, materials used, and employees	1~3	✔	✔	✔	
Overall						
EN30	Total environmental protection expenditures and investments	1,3	✔	✔		✔
Total			**30**	**18**	**28**	**8**

Table II shows that total 30 indicators are quantitative in which 18 have also qualitative features; and 28 indicators address environmental impacts and 8 address mitigation initiatives. This indicator spread reflects the importance of number data for indicators and need for supplementary explanations. In the measurement, scales 1 and 2 are equivalent and belong to qualitative and mitigation initiative indicators; scales 3 and 4 belong to quantitative and environmental impact indicators. In the 12 solely quantitative indicators, nine are scale 3 including materials (EN1), energy (EN3, 4, 5), water (EN8), emissions (EN16, 17, 19, 24); two are scale 4 including EN2 and EN27; EN10 covers both 3 and 4 because it needs to report "percentage" and "total volume" of water recycled and reused.

TABLE III: INDICATOR DISCLOSURE EXAMINATION OF COMPANY C1

Indicators	Original Scale	Compar-ison	Actual scale	Impacts and Initiatives
EN1	3	>	0	Not disclosed
EN2	4	>	0	Not disclosed
EN3	3	=	3	Fuel consumption (L): 6.9 mil. in Germany, 4.1 mil. in Europe, 950 mil. in Asia-Pacific.
EN4	3	=	3	Electricity consumption (GJ), 880,000 in Germany, 620,000 in Europe, 910,000 in Asia-Pacific.
EN5	3	=	3	Energy management: 1.37 mil. euros for hospital energy saving, illumination energy saving 40%; school natural gas and power cost saving 70%; 4.5 mil. euros saved for infrastructure in the next 10 years.
EN6	1,3	>	2 0	Renewable energy development (wind power, hydro power, solar power, thermal energy). Reduced energy not disclosed.
EN7	1,3	=	4	Office building energy saving 35%
EN8	3	=	3	Water use (m^3): 210,000 in Germany, 120,000 in Europe.
EN9	1,3	NA	-	Not applicable
EN10	3,4	>	0	Not disclosed
EN11	1~3	=	2	Ensure plant and species not invaded.
EN12	1~4	=	1	Hydro power plant located in high plain protection area.
EN13	1~3	=	1	No further land development.
EN14	1~4	=	1	Propose environment impact avoidance strategy. Protect local flora and fauna.
EN15	1~3	=	1	New combustion equipment to reduce interference noise.
EN16	3	=	3	CO_2 emissions (ton): 380,000 in Germany, 290,000 in Europe, 2.6 mil. in Asia-Pacific.
EN17	3	>	0	Not disclosed (in other report)
EN18	1,3	=	3	New transportation system reduces 20% CO_2 emissions.
EN19	3	NA	-	Not applicable
EN20	1,3	>	-	Not disclosed
EN21	1,3	=	3	Oxley and Wacol plants to treat wastewater 66 mil. liters /day.
EN22	1,3	>	0	Not disclosed
EN23	1,3	>	0	Not disclosed
EN24	3	>	0	Not disclosed
EN25	1~3	NA	-	Not applicable
EN26	1~4	=	1 4	Rainwater capture and solar panel systems for stadium use. 95% of the waste building was recycled.
EN27	4	NA	-	Not applicable
EN28	1,3	>	0	Not disclosed
EN29	1~3	=	3	Average CO_2 emissions from employee transportation 154g/km.
EN30	1,3	>	0	Not disclosed
Total	**26**	**>**	**15**	**58%**

TABLE IV: INDICATOR DISCLOSURE RATES OF EIGHT COMPANIES

Companies	Constructors				Developers		Suppliers		Disclo-sure (%)
Indicators	**C1**	**C2**	**C3**	**C4**	**D1**	**D2**	**M1**	**M2**	
EN1		✔				✔			25
EN2							✔	✔	25
Materials Subtotal/Average	**0**	**1**	**0**	**0**	**0**	**1**	**1**	**1**	**25**
EN3	✔	✔		✔	✔	✔	✔	✔	88
EN4	✔	✔		✔	✔	✔	✔	✔	88
EN5	✔		✔		✔	✔	✔	✔	75
EN6			✔	✔		✔		✔	50
EN7	✔		✔			✔		✔	50
Energy Subtotal/Average	**4**	**2**	**3**	**3**	**3**	**5**	**3**	**5**	**70**
EN8	✔	✔		✔	✔	✔	✔	✔	88
EN9	NA		NA	✔					17
EN10						✔	✔	✔	38
Water Subtotal/Average	**1**	**1**	**0**	**2**	**1**	**2**	**2**	**2**	**50**
EN11	✔	✔		✔	✔	✔	✔	✔	88
EN12	✔			✔	✔		✔	✔	63
EN13	✔				✔	✔	✔	✔	63
EN14	✔	✔			✔	✔	✔	✔	75
EN15	✔	✔		✔	✔				50
Biodiversity Subtotal/Average	**5**	**3**	**0**	**3**	**5**	**3**	**4**	**4**	**68**
EN16	✔	✔		✔	✔	✔	✔	✔	88
EN17		✔							13
EN18	✔	✔					✔	✔	50
EN19	NA						✔		17
EN20		✔					✔	✔	38
EN21	✔					✔			25
EN22		✔		✔	✔	✔			50
EN23		✔	✔		✔				38
EN24		✔	NA		✔				29
EN25	NA		NA	✔					17
Emi., Eff., Waste Subtotal/Average	**3**	**7**	**1**	**3**	**4**	**3**	**4**	**3**	**37**
EN26	✔	✔	✔	✔	✔	✔	✔	✔	100
EN27	NA		NA						0
Products/services Subtotal/Average	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**57**
EN28			✔	✔	✔	✔	✔	✔	75
Compliance	**0**	**0**	**1**	**1**	**1**	**1**	**1**	**1**	**75**
EN29	✔	✔	✔	✔	✔		✔	✔	88
Transport	**1**	**1**	**1**	**1**	**1**	**0**	**1**	**1**	**88**
EN30		✔			✔		✔	✔	50
Overall	**0**	**1**	**0**	**0**	**1**	**0**	**1**	**1**	**50**
Total	15	17	7	14	17	16	18	19	**53**

B. Examination of Indicator Disclosure

After the characteristics of the 30 indicators were understood, the indicators in the CSR reports of the eight companies were reviewed to examine their actual conformity to the compilation requirements or suggestions of the GRI guidelines. Table III is the examination example of the indicator disclosures of Company C1. The original scales of the 30 indicators are listed on the left to be compared by the scales of the company-disclosed indicators. The actual scales were determined from th impacts e and initiatives written in the CSR report. For example in EN2, the compilation requires the percentage of materials used (the ratio scale 4). But the CSR report had only descriptions corresponding to scale 1 without the percentage. So EN2 was not (sufficiently) disclosed and is put a " >" in the comparison column and a "0" in the atual scale column in Table III.

For EN3 direct energy consumption, the CSR reported fuel consumption numbers in different regions as shown in the impacts and initiatives column in Table III. So EN3's disclosure was considered achieved and put as "3 = 3" in the comparison. Generally, whether an indicator is considered disclosed depends on the degree of disclosure. For example in EN6, although some initiatives such as renewable energy were stated in the report, the important part of reduced energy amount was not. So this indicator was not considered disclosed. EN7 was considered disclosed because the important part of the office building energy saving 35% was written in the report. Sometimes a company may denote certain indicators are not applicable to the company's operation. In this case, it is recorded "NA" in Table III such as the four indicators of EN9, 19, 25 and 27. The total number of applicable indicators is hence reduced to 26. The number of actual scales in conformity to the requirements is 15. So the total disclosure rate of company C1 is 58% (=15/26).

C. Disclosure Rates and Levels of Indicators

The examination method in the **B** section was used on the other seven companies, and the final disclosures of the indicators of the eight companies are shown in Table IV. For example, the checks under company C1 are taken from those of Table III. The average disclosure rate of the eight

companies is 53%. Most companies disclosed over half of the 30 indicators except C3. The two suppliers disclosed 18 and 19 out of the 30 indicators, higher than the two developers (17 and 16) and four constructors (15, 17, 7 and 14). Suppliers provide materials or equipment which are produced in manufacturing plants. The data for the indicators are easier to collect and have been collected earlier than construction.

The 30 indicators belong to seven aspects and have different disclosure rates. They, from high to low, are transport 88% > compliance 75% > energy 70% > biodiversity 68% > products and services 57% > water, overall 50% > emissions, effluents, and waste 37% > materials 25%. Materials are very important input to construciton activities and play a vital role in environmental perforamnce. But the two material indicators of EN1 and EN2 have the lowest disclosure rate of 25%. As shown in Table IV, most constructors and developers did not report the information. This together with the blanks in the cells in Table IV desreves further study.

Table V shows the levels and sequence of indicators by their disclosure rates. There are 10 indicators in the high level of disclosure (above 75%), 8 medium disclosure indicators (50%~75%), and 12 low disclosure indicators (below 50%).

TABLE V: SEQUENCE OF INDICATORS BY DISCLOSURE RATE

Disclosure Level	Quantity (12)	Q &Q (18)	Indicator Description	Disclosure Rate (%)
High (10)		EN26	Initiatives to mitigate environmental impacts of products and services, and extent of impact mitigation	100
	EN3		Direct energy consumption	88
	EN4		Indirect energy consumption	88
	EN8		Total water withdrawal by source	88
		EN11	Potential impacts of location of land in or adjacent to protected areas	88
	EN16		Total direct and indirect GHG emissions by weight	88
		EN29	Significant environmental impacts of transporting products, materials used, and employees	88
	EN5		Energy saved due to conservation and efficiency improvements	75
		EN14	Strategies, current actions, and future plans for managing impacts on biodiversity	75
		EN28	Monetary values of significant fines and total number of non-monetary sanctions	75
Subtotal (%)	**5 (17)**	**5 (17)**		**85**
Medium (8)		EN12	Significant impacts of activities, products, and services	63
		EN13	Habitats protected or restored	63
		EN6	Initiatives to provide energy-efficient or renewable energy, and reductions in energy requirements	50
		EN7	Initiatives to reduce indirect energy consumption and reductions achieved	50
		EN15	No. of species with habitats in areas affected by operation, by level of extinction risk	50
		EN18	Initiatives to reduce GHG emissions and reduction achieved	50
		EN22	Total weight of waste by type and disposal method	50
		EN30	Total environmental protection expenditures and investments	50
Subtotal (%)	**0 (0)**	**8 (27)**		**53**
Low (12)	*EN10*		Percentage and total volume of water recycled and reused	38
		EN20	SOX、NOX, and other significant air emissions by type and weight	38
		EN23	Total number and volume of significant spills	38
	EN24		Weight of transported and treated hazardous waste	29
	EN1		Materials used by weight or volume	25
	EN2		Percentage of recycled materials used	25
		EN21	Total water discharge by quality and destination	25
		EN9	Water sources significantly affected by withdrawal of water	17
	EN19		Emissions of ozone-depleting substances by weight	17
		EN25	Water bodies and related habitats significantly affected by the discharge of water and runoff	17
	EN17		Other relevant indirect GHG emissions by weight	13
	EN27		Percentage of products sold and their packaging materials that are reclaimed	0
Subtotal (%)	**7 (23)**	**5 (16)**		**24**

IV. DISCUSSION

The 10 high disclosure indicators include EN3, 4, 5, 8, 11, 14, 16, 26, 28, and 29 with an average disclosure rate of 85%. In the five solely quantitative indicators, EN3, 4, and 8 are commonly measurable and achievable. Their data sources can be simply oil, electricity and utility bills. EN16 has to collect data from other sources and make conversion to calculate the total direct and indirect GHG emissions by weight. It is an issue of international concern and also the key performance reported by many companies. It may have difficulty in collecting data in the beginning of CSR reporting. But it will become a base for comparison or benchmarking after the data have been collected for a period of time. EN5 of energy saved would be tracked by companies because it provides incentive for saving cost and reducing CO_2.

For the other five qualitative and quantitative (Q&Q) indicators, EN26 (products and services), EN11 and 14 (biodiversity), and EN29 (transport) explained mitigation initiatives to supplement the quantitative indicators. This is the complete disclosure of environmental information [2]. EN28 of monetary fines has been disclosed by companies in recent years for observation and tracking its reduction. Reduction in environment violation can lower the economic risk and raise the company image.

The eight medium disclosure indicators (EN6, 7, 12, 13, 15, 18, 22 and 30) all belong to Q&Q type. Their disclosure rates vary little from 50% to 63% with an average of 53%.

EN12 and 13 have a higher rate of 63% with ecology issues such as developed environment and influence to species illustrated. Q&Q indicators are usually accompanied by the explanations of environmental impacts and mitigation initiatives. For example, EN7 would explain initiatives to reduce indirect energy consumption and reductions achieved.

The 12 low disclosure indicators (EN1, 2, 9, 10, 17, 20, 21, 23, 24, 25 and 27) have an average rate of 24%. In the seven solely quantitative indicators, EN1 total materials are the major input to construction activities but their disclosure is low probably because the existing practices are not used to collect relevant data. EN2 recycled materials are even less emphasized so the data are also not collected. For the other indicators such as EN10 (recycled water amount), 20 (air emissions) and 21 (water discharge), both quantitative and qualitative data are needed to make the disclosure more complete.

V. Conclusion

This study investigated the disclosure of the environmental performance indicators in the CSR reports of eight construction-related companies. The measurement scale method was used to classify the 30 GRI indicators into quantitative and qualitative as well as environmental impact and mitigation initiative types. Then the actual indicators of the eight CSR reports were evaluated and divided into high, medium and low levels based on the disclosure rates. This is to show which aspects of environmental performance are easier or more difficult to disclose and explain.

For a construction company to publish its environmental performance, the indicators of high disclosure level can be disclosed with priority from quantitative ones such as energy (EN3, 4), water (EN8), and GHG emissions (EN16), and supplemented by qualitative indicators such as EN11 (land and protected area), 26 (products and services) and 29 (transport) to explain the mitigation initiatives for the environmental impacts caused. Then those of medium disclosure levels can follow. The indicators of low disclosure level can be considered once a company has capacity to do so. But EN1 and 2 are the input materials for the construction industry. A company needs to collect relevant data, evaluate their impacts, and disclose them early to make the resource consumption more transparent.

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