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A Research Monograph of the Printing Industry Center at RIT

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R·I·T Printing Industry Center
An Alfred P. Sloan Foundation Center

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With Thanks

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Introduction

The application of sustainability to business strategy is an actively debated topic in the research literature (Gladwin, Kennelly, & Krause, 1995; Hart, 1995; Shrivastava, 1995; Starik & Rands, 1995). As environmental concerns in society continue to evolve, the sustainable performance of firms is likely to become an increasingly important driver of both competitiveness and profitability. This is clearly true for the printing industry, where environmental pressures have been a growing issue for equipment manufacturers, printers, and print users. The overall environmental performance of firms in the printing industry can collectively have a high aggregate impact and is likely to come under increased scrutiny from external interest groups (Rowe & Hollingsworth, 1996).

The printing industry has responded aggressively to these challenges over the years with an increase in more sustainable print activities. Accompanying this increase are technological innovations such as ink chemistries, printing process efficiencies, and new business models. However, many challenges still remain on the path to "being green." While many companies are trying to measure sustainability, there is much uncertainty as to how this should be done.

The RIT Sustainable Print Systems Laboratory recently conducted a survey of companies in the printing industry to begin to characterize the state of sustainability practices and to better understand the specific needs and challenges of measuring the sustainability of print. The survey focused on self-reported measures of sustainability and the factors that might influence this measurement.

More specifically, the goals of this survey were:

- To establish a baseline of the current state of adoption and implementation of sustainability practices within the printing industry. This includes:
  - Participation in certification programs, and
  - Development and use of sustainability metrics.
- To identify organizations that are at the forefront in the areas referenced above for additional in-depth research.

Theory

In order to fulfill the aforementioned goals, the survey will be analyzed for evidence of environmental sustainability practices within the printing industry and evidence of the integration of metrics into individual firm's decision making. Five major practices were examined:

1. The development of an official sustainability policy,
2. The development and use of sustainability metrics,
3. The development and use of Life Cycle Assessment (LCA) and carbon footprint metrics,
4. Participation in industry-wide environmental certification programs, and
5. The impact of environmental metrics on corporate decision making.

Sustainability Policy

The presence of an official sustainability policy within a firm can help define its environmental responsiveness (Henriques & Sadorsky, 1996). This was viewed as the minimum level of commitment, but it represents an important step. A sustainability policy sets the foundation to identify firm-level processes and demonstrates the firm's willingness to communicate environmental sustainability to both internal and external stakeholders. It helps define the vision, mission, and values of a firm toward sustainability in a holistic manner.

Metrics and Measurements

Metrics set a degree of discipline that requires managerial and financial integration and also set a benchmark for continuous improvement (Lefebvre, Lefebvre, & Talbot, 2003). They serve as a means to turn generic visions into actionable items and help define the groundwork for tracking and communication of sustainability. Many metrics are related to sustainability that companies can measure, such as energy use, material use, waste emissions, and any number of physical and financial measures. This analysis does not put forth any conclusions as to which metrics system is most beneficial; it simply attempts to characterize the types of metrics and methods in terms of level of awareness, level of implementation, and level of use within a particular firm from a managerial perspective.

We look at three types of metrics: sustainability, Life Cycle Assessment (LCA), and carbon footprinting. The first step toward product stewardship is to define and measure a product's impact. LCA is a valuable tool and methodology that can be applied both to operational and marketing processes (Curran, 1996; Handfield, Walton, Seagers, & Melnyk, 1997; Bas de Leeuw, 1999). Another important tool to help identify life-cycle environmental costs is carbon footprinting. This methodology helps to communicate a

product's 'global warming potential' and is particularly useful if a firm is interested in communication with customers who consider this an important impact. This analysis also takes a specific look at the following tools and methodologies:

- Economic Input-Output LCA,
- Stream-Lined LCA,
- Sima-Pro,
- Eco-Indicator,
- Cambridge Engineering Selector [CES] Material Selector,
- Embodied Energy Analysis,
- Material Input per Unit of Service,
- Ecological Footprints, and
- Thermodynamic and Flow Analysis.

Certifications

Best practices are often disseminated through industry and trade associations (Sharma & Henriques, 2005). In the printing industry many associations exist that have developed certification programs dealing both comprehensively or specifically with sustainability. Some of these certification programs include the Sustainable Green Printing Partnership (SGP), Forest Stewardship Council (FSC), Sustainable Forestry Initiatives (SFI), and the Programme for the Endorsement of Forest Certification (PEFC). Another important certification program is ISO 14000, which is a more general inter-industry certification closely tied to the ISO 9000 quality standard. ISO 14000 is quickly becoming a "global passport for international trade" (Marcus & Willig, 1997). Several of these certifications help to promote a 'ripple effect' of sustainability throughout the supply chain, since the primary contractor may also require their suppliers to be certified. Of course, the choices available to companies in the printing industry are not limited to the above, and many companies have developed their own internal or customer-defined certifications related to sustainability.

Influence of Sustainability on Decision Making

This analysis attempts to define systemic inter-organizational integration of sustainability along four main levels: (a) alignment of sustainability with the marketing organization of a firm; (b) alignment with the executive/corporate organization; (c) alignment with the business or functional unit organization (for example, supply chain, R&D, HR); and (d) alignment of sustainability with the day-to-day operational organization of a firm (for example, design decisions, manufacturing).

Methodology

The participants in this study were derived from two sources: industry partners of RIT's Printing Industry Center and members from the Society for Imaging Science and Technology (IS&T). The exact number of individuals contacted is not known because the IS&T mailing list was not made visible to the researchers of this study, and there were no restrictions placed on to whom the survey could be forwarded. These organizations were selected because their members are from all over the globe and are a cross-sectional representation of companies at all stages of the print value chain.

Survey Questions

In order to collect the data to support the objectives of this study, a survey was developed that was sent out to the firms and individuals discussed above. This survey consisted of 31 questions that focused on the following areas:

- Type and state of sustainability policies that the firms have instituted,
- Sustainability programs in which the firms participate,
- Sustainability measurement practices, and
- Sustainability measurement tools and methods awareness.

Before it was released to the population described above, the survey was pre-tested on two sample respondents from North America and Europe for a critique of the questions and the survey design. After some minor modifications, the survey was released with instructions to forward the link to anyone within the industry who would be interested in taking the survey. The survey was distributed online using SurveyMonkey.com and was available from August 19, 2009 to October 12, 2009. Survey questions are presented in Appendix A.

Survey Results

Survey Demographics

A total of 120 individuals started the survey, and approximately 87% completed all or some of the questions—resulting in a sample of 105 total respondents. The demographic information of these respondents is summarized as follows:

Geographic Distribution

Approximately 77% of surveyed companies have headquarters located in the United States, followed by 14% in Europe and 7% in Asia. A smaller number of companies have headquarters located in Canada or South America. No respondent companies have headquarters located in Mexico or other locations. Although the majority of

the companies were headquartered in the US, their business operations were globally distributed—36% of surveyed companies had operations in North America, followed by 22% in Europe, 18% in Asia/Pacific, 13% in South or Central America, and 11% in the Middle East or Africa.

Company Size

A disproportionate fraction of respondents were from large enterprises (41% of the respondents had 1,000 or more employees). The remainder of the respondents came from small-to-medium enterprises: 16% of respondents had between 250 and 999 employees, 8% had between 100 to 249 employees, 19% had between 20 and 99 employees, and 16% had less than 20 employees.

Organizational Responsibilities

Most respondents (67%) indicated that their functional position within their organizations was in management, followed by smaller percentages indicating that they were involved in manufacturing (4%), IT (4%), support (2%), sales (2%), and creative functions (1%). Interestingly, 20% of respondents reported that their job function was not adequately described by the provided categories. With regard to tenure in the organization, 30% of respondents indicated that they had worked for 21 or more years in their organizations. Twenty-eight percent (28%) indicated they had worked between 10 and 20 years in their organizations; 15% indicated between 5 and 10 years; 22% indicated between 2 and 5 years, and 5% indicated they had worked for 1 year in their organizations.

Print Value Chain

Survey respondents were asked to provide a general impression of the percentage of customers their organizations have in various markets, as well as the percentage of revenue that is derived from the different segments of the print value chain. The market segments provided in the survey included consumers, office, commercial, packaging, government and other sectors. It is interesting to note that more than 70% of the respondents derive less than 25% of their customers from the consumers, office, packaging, government and other segments, which suggests a more uniform distribution among these markets. The notable exception is the commercial market segment, in which close to 45% of the respondents derive at least 50% of their customers. Figure 1 provides a more detailed breakdown of the survey responses.

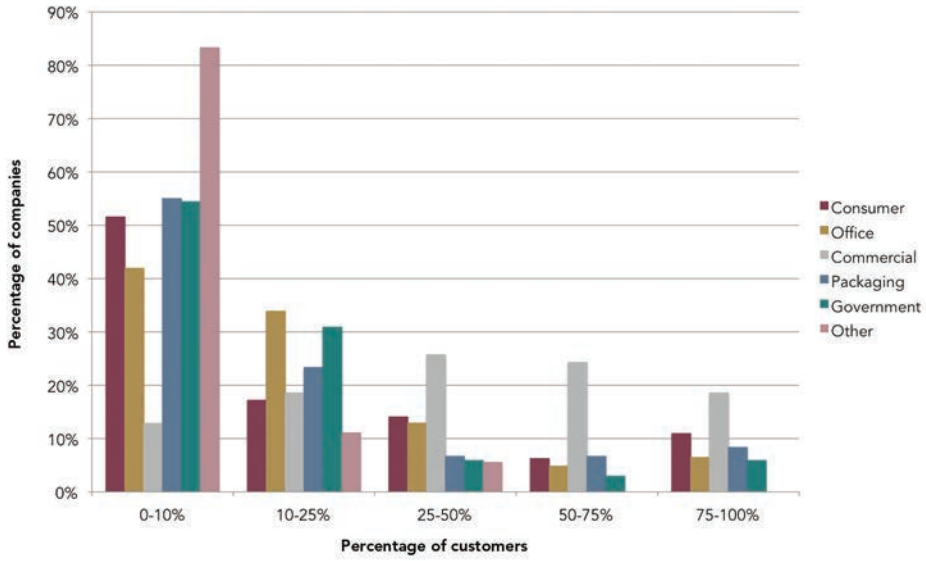

Figure 1. Percent of customers in market

These findings seem to be consistent with respondents' reporting of revenue percentages obtained in different segments of the print value chain. As seen in Figure 2, a significant fraction of respondents' revenues were more uniformly distributed among "content creation," "workflow and data management," "print equipment manufacturing," "print production," "printer services consulting and management," "end-of-life (EOL) services," and "other." However, for over 50% of respondents, at least 50% of their revenues came from print production. Thus, these survey data may be more representative of companies that provide print production services to commercial customers.

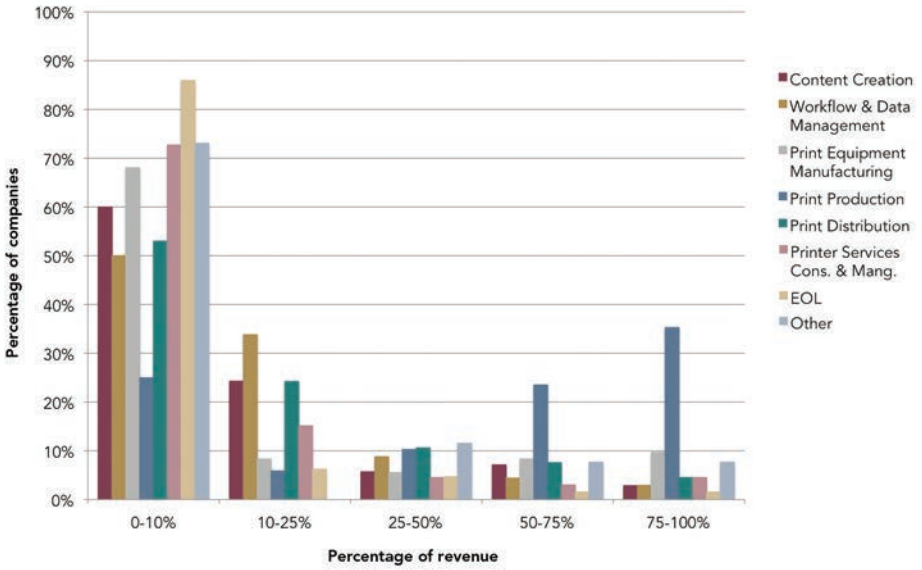

Figure 2. Percent revenue generated in various segments of the print value chain

Policies and Practices

Sustainability Policies

Survey respondents were asked to provide a general overview of their company's practice of sustainability policies. Respondents were given the options of indicating the degree of implementation of any sustainability policy in which their company was engaged. No specific policy was pre-indicated to respondents. The responses are summarized in Figure 3, which shows that 37% of respondents indicated that their company had a formal sustainability policy in place; 17% indicated that they had an informal sustainability policy in place; 14% indicated that a sustainability policy was under development; 27% indicated that their company did not have any sustainability policy in place; and 5% indicated that they were not sure as to the status of a sustainability policy within their organization. For those companies that had a formal or informal sustainability policy, 99% of respondents indicated that this policy included environmental areas; 63% indicated that it included economic areas; 75% indicated that it included social areas; and 4% indicated "other."

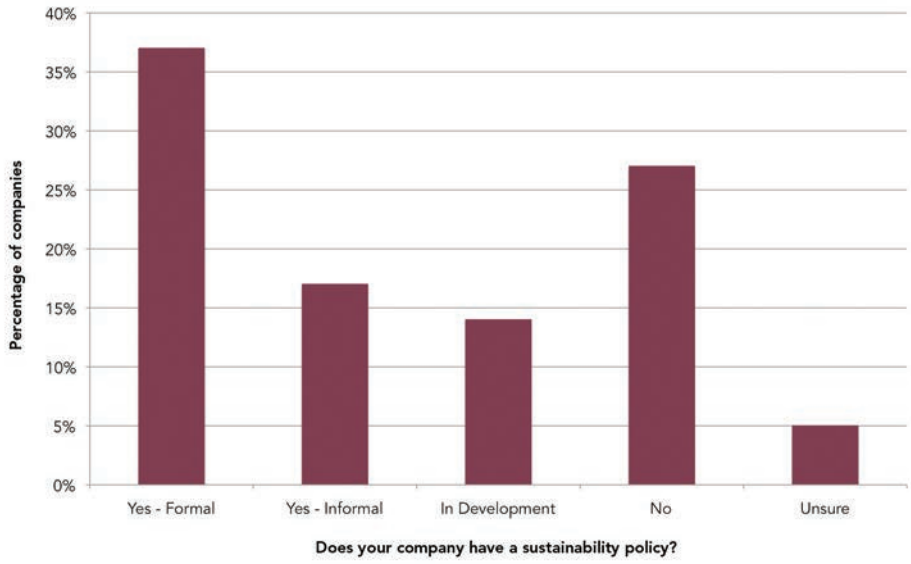

Figure 3. Presence of sustainability policy

Similarly, survey respondents were asked to indicate their company's involvement in corporate social responsibility (CSR). Fifteen percent of respondents indicated that CSR was already covered under their sustainability policies; 32% indicated that their company had a formal and written CSR policy in place; 19% indicated that their company had an informal and unwritten CSR policy; 1% indicated that their company was currently in the process of developing a CSR policy; 27% indicated that their company did not have a CSR policy; and 5% indicated that they were unsure about the status of corporate social responsibility within their organization.

Lastly, respondents were asked to provide a general overview of their company's environmental policies. Nineteen percent of respondents indicated that environmental policies were already covered under their sustainability policy; 2% indicated that it was part of their company's corporate social responsibility policy; 34% indicated that their company had a formal and written environmental policy; 18% indicated that they had an informal and unwritten environmental policy; 5% indicated that it was currently in development; 14% indicated that their company had no environmental policy in place; and 7% indicated that they were not sure about their company's status on environmental policies.

Sustainability Measures and Metrics

Use of Sustainability Measures

Surveyed companies were asked to indicate whether or not they used sustainability measures for one or more of the products they offer. As seen in Table 1, approximately half (54%) of the respondents already had sustainability metrics or they were under development. Most of the companies (68%) developed these metrics internally. A smaller percentage used a consulting company (18%), university (12%), or "other" (4%) for development.

Table 1. Use of metrics

Metric	Yes	Under development	No	Unsure
Sustainability metrics	35%	19%	36%	10%
LCA	23%	15%	49%	13%
Carbon footprint	31%	16%	45%	8%

Only 35% of the firms reported conducting LCAs of any kind. For these companies, 64% of respondents indicated that their LCA development efforts were internal; 19% indicated that it was accomplished with an outside consulting company; 12% indicated they collaborated with a academic university; and 5% indicated "other." Interestingly, as seen in Table 2, an average of 63% of respondents indicated that they had not heard of any of the quantifying methods provided in the survey. An average of 9% of companies indicated that they were currently using at least one of the methods provided. The most popular method in use was Economic Input-Output LCA (18% of respondents).

Table 2. Methods of quantifying environmental impact

Method	Not heard of it	Not planning to use it	Considering using it	Planning to use it	Use it now
Economic Input-Output Life Cycle Analysis (LCA)	52%	13%	14%	2%	18%
Stream-lined LCA	65%	11%	11%	5%	7%
Sima-Pro	77%	13%	5%	2%	2%
Eco-Indicator	64%	17%	11%	4%	4%
Cambridge Engineering Selector [CES] Material Selector	76%	13%	5%	4%	2%
Embodied Energy Analysis	71%	13%	7%	5%	4%
Material Input per Unit of Service	56%	14%	14%	4%	13%
Ecological Footprints	45%	16%	20%	4%	16%
Thermodynamics and Flow Analyses	59%	18%	9%	5%	10%
Other	69%	14%	3%	3%	10%

Almost half of the respondents (47%) reported they had conducted a carbon footprint analysis or were in the process of doing so. Of these companies, 68% of respondents indicated that this was an internal effort; 19% indicated that it was in collaboration with an outside consulting company; 8% indicated that they worked with an academic university; and 6% indicated "other." These results can be seen in Table 3.

Table 3. Developers of metrics

Metric	Internal effort	Collaboration with consulting company	University	Other
Sustainability metrics	68%	18%	12%	4%
LCA	64%	19%	12%	5%
Carbon footprinting	68%	19%	8%	6%

Participation in Environmental Certification Programs or Standards

Survey respondents were asked to indicate the degree to which their companies were involved in various environmental certification programs and standards. Respondents were provided with a wide range of certification and standards options, including external certification programs, self-certification programs, and customer-required certification programs. The choices for external certification programs included the Sustainable Green Printing Partnership (SGP), Forest Stewardship Council (FSC), ISO 14000, LEED certification, Program for the Endorsement of Forest Certification (PEFC), The Natural Step, and self certification. An "other" option was provided for respondents to enter their own response.

Results are provided in Table 4. Respondents were provided with a range of possible responses to gauge the degree of participation.

Table 4. Involvement in print-related certification programs

Certification program	Have not heard of it	Not planning to implement	Considering	Planning to implement	Implemented in part	Implemented in full
SGP	35%	16%	28%	9%	11%	2%
FSC	23%	20%	12%	8%	15%	22%
SFI	23%	34%	19%	4%	8%	13%
ISO 14000	19%	35%	15%	4%	12%	16%
LEED	50%	30%	15%	0%	2%	3%
Self/Customer Certified	41%	26%	13%	7%	9%	4%
PEFC	47%	29%	11%	2%	5%	7%
The Natural Step	72%	18%	5%	1%	1%	3%
Self	47%	26%	13%	4%	4%	6%
Other	44%	22%	8%	6%	8%	13%

The results of this question indicated that participation in various environmental certifications and standards in the printing industry is wide-ranging. Knowledge of many of the programs was also rather low. On average, about 40% of respondents had not heard of one or more of the certification programs presented in this survey. Specifically, 72% of respondents had not heard of The Natural Step; 50% had not heard of LEED certification; 47% had not heard of the Program for the Endorsement of Forest Certification (PEFC); 35% had not heard of the Sustainable Green Printing Partnership (SGP); 23% had not heard of the Forest Stewardship Council (FSC) and Sustainable Forest Initiative (SFI); and 19% had not heard of ISO 14000.

A smaller fraction of companies had heard of the various certification programs and standards presented in the survey but were not planning to implement them. On average, 26% of companies were not planning to implement any certification or standard. Specifically, 35% were not planning to implement ISO 14000; 34% were not planning to implement SFI; 30% were not planning to implement LEED; 29% were not planning to implement PEFC; 20% were not planning to implement FSC; 18% were not planning to implement The Natural Step; and 16% were not planning to implement SGP.

Companies considering or planning to implement any of the certification programs listed in the survey averaged around 18% of respondents. Specifically, 37% were considering or planning to implement SGP; 23% were considering or planning to implement SFI; 20% were considering or planning to implement FSC; 19% were considering or planning to implement ISO 14000; 15% were considering or planning to implement LEED; 13% were considering or planning to implement PEFC; and 6% were considering or planning to implement The Natural Step.

A relatively small percentage of respondents indicated that they had implemented any of the certification or standards named in the survey either partially or in full. Specifically, 37% indicated a partial or full implementation of FSC; 27% indicated partial or full implementation of ISO 14000; 21% indicated partial or full implementation of

SFI; 13% indicated partial or full implementation of SGP; 12% indicated partial or full implementation of PEFC; 5% indicated partial or full implementation of LEED; and 4% indicated partial or full implementation of The Natural Step.

In addition to the above choices of certification programs and standards, respondents were given the option to indicate if they participated in a self-certification program or a customer-required certification program. Thirty-seven percent indicated that they were considering or planning to implement these certifications, and 23% indicated that they partially or fully participated in a self-certification or customer-required certification program. We also left space for respondents to fill in an "other" program. Fourteen percent indicated that they were considering or planning to implement such a program, and 21% indicated that they participated either partially or fully in a certification program other than the ones listed in the survey. The "other" program responses included the following:

- ISO 12647,
- Blue Angel,
- Nordic Swan,
- Eco Label,
- Carbon Disclosure Project,
- Green Tier,
- Global Environmental Management Initiative,
- EPA National Partnership of Environmental Priorities,
- World Resource Initiative,
- Forest Landscape Initiative,
- EPA's SmartWay Transport Partnership,
- SoySeal Ink Certification, and
- Green Marketing Coalition.

Influence of Sustainability on Decision Making Within Organizations

Influence on Measuring Sustainability

Survey respondents were asked to indicate the degree to which various factors have influenced the approach toward measuring sustainability within their organizations. They were provided with various factors of influence, including supplier pressure, customer pressure, regulatory standards, company image, competitor's behavior, strategic positioning, and leadership's interest in sustainability. The weighting for the

influence of each factor ranged from "1 - Not at all" to "6 - To a great extent." Responses are provided in Table 5.

Respondents indicated that company image has a heavy influence on sustainability: 70% of respondents rated this a 5-6, while no respondents rated this a 1. Strategic positioning and leadership's interest in sustainability also represented very significant influencing factors, with 65% and 60% of respondents attributing a weighting of 5-6, respectively, and only 6% and 10% of respondents attributed a weighting of 1-2, respectively. Customer pressure and regulatory standards rounded out the factors that have a strong influence on the measurement of sustainability. These factors respectively received 49% and 40% of respondents' answers in the 5-6 range, while 11% and 17% of respondents' answers were in the 1-2 range, respectively.

Table 5. Factors that influence the measuring of sustainability

Factor	1 - Not at all	2	3	4	5	6 - To a great extent
Supplier pressure	38%	13%	20%	13%	9%	7%
Customer pressure	4%	6%	23%	17%	23%	26%
Regulatory standards	6%	11%	26%	17%	23%	17%
Company image	0%	2%	9%	19%	36%	34%
Our competitor's behavior	17%	6%	28%	30%	15%	4%
Strategic positioning	2%	4%	15%	15%	42%	23%
Leadership's personal interest in sustainability	6%	4%	13%	17%	33%	27%

Factors that provide a lower influence on the measurement of sustainability include competitor's behavior and supplier pressure. Each received 19% and 16% in the ranges of 5-6, respectively ,while receiving 23% and 51% of responses in the 1-2 weight range. It seems that supplier pressure plays little role in influencing sustainability measures upstream in the supply chain.

Influence of Sustainability, LCA, and Carbon Footprint Measures on the Decision-Making Process

Survey respondents were asked to indicate the degree to which their use of sustainability, LCA, or carbon footprint measurements influenced the decision-making process within their organizations. The purpose of this question was to gauge the depth of use of measures and metrics on sustainability within the decision-making process of an organization. Respondents were given the options to chose the degree of influence within several segments of the decision-making process, ranging from marketing or company image decision making, corporate or executive decision making, business unit decision making (such as supply chain, R&D, HR), or decision making in day-to-day activities (such as design decisions and supplier selection). The weighting range of influence within each segment of the decision-making process ranged from "1 - We do not measure these items" to "6 - To a great extent."

Responses to this question are shown in Figure 4. The influence of sustainability measures on the various segments of decision making provided in the survey seems to be relatively uniform. However, several decision-making segments do exhibit a heavier influence and use of sustainability metrics than others. Marketing and executive-level decision-making seems to make the heaviest use of sustainability measures and metrics. Thirty-four percent of respondents using sustainability measures or metrics indicated a 5-6 weighting for marketing/image, while only 19% indicated a low weighting of 2-3 (1 indicating no use of measures or metrics at all). Likewise, 31% of respondents indicated a high weighting of 5-6, and 23% indicated a low weighting of 2-3 for executive-level decision making. These responses indicate that in the higher levels of decision making, sustainability measures and metrics are more often used.

In the lower levels of the decision-making process, however, this relationship isn't as pronounced. In the business unit level of decision making, 28% of respondents indicated a high weighting of 5-6 for the influence of sustainability measures, while 21% indicated a low weighting of 2-3. Likewise, in the day-to-day activities level, 28% of respondents indicated a high weighting of 5-6, while 23% reported a low weighting of 2-3. While the results indicate a level of increasing influence for sustainability measures within these decision-making segments, this influence is relatively lower than at the executive and marketing levels of decision making. Furthermore, a higher percentage of companies indicated a low level of influence of sustainability measures at the business unit and day-to-day activities levels.

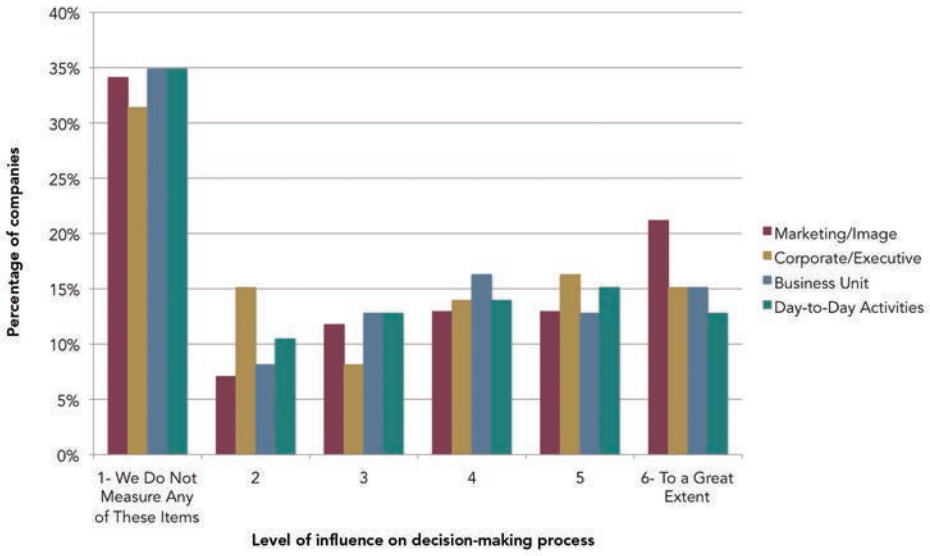

Figure 4. Influence of sustainability measures on decision-making processes

Obstacles

We also asked a more open-ended question at the end of the survey: What are the biggest difficulties in measuring and implementing sustainable practices? There seemed to be three major themes: data acquisition, resources, and lack of a standard process. As one respondent succinctly said, "Cost, measurement, lack of standards." Table 6 illustrates some of the representative comments.

Table 6. Obstacles to measuring and implementing sustainable practices by theme

Resources	Data Issues	Standardization
Resources for such non-value added activities	Getting data from suppliers	Applying standardized methods of measuring
Cost and complexity	Gathering all the information	Lots of programs and confusion
Bandwidth of business to take on new projects and budget	Getting the right tools and information	Changing standards and non-uniform standard
Time to set up the program	No clear best method and lack of credible data	Awareness of standards applicable to sites and global coordination and implementation
Time and money	Lack of knowledge [regarding] carbon footprint of raw materials (inks, substrates, etc.) and end-of-life analysis (Are products recycled or landfilled, etc?)	No standards. Competitors use whatever messaging that promotes their products

Impact of Company Size

One of the distinguishing aspects of the printing industry is the high percentage of smaller firms. Thus, given the skewed nature of our sample toward larger firms, we wanted to investigate the impact of firm size on some of our variables. Firm size is an important indicator of the resource-based limitations and opportunities of a company. Larger enterprises (LEs) have more resources, both financial and non-financial, to integrate sustainability concerns into their business and product life cycle (Lefebvre et al., 2003). Most research in the field of sustainability maintains that small-to-medium-sized enterprises (SMEs) tend to lag behind in environmentally friendly behavior compared to larger enterprises (Bianchi & Noci, 1998; Hillary, 2000; Hutchinson & Hutchinson, 1996). Because of their smaller size, SMEs tend to be less inclined to employ technological or managerial solutions developed by, and for, larger organizations (Tilley, 1999). Furthermore, the physical limitations of the owner's time and information are closely linked to the environmental performance of SMEs (Schaper, 2002). Based on this wide body of literature, the researchers expected that firm size would be negatively related to the adoption of metrics, policies, and certifications.

Method

Fisher's Exact Test was chosen for analyzing the significance of association between the variables of interest. Fisher's Exact Test is a non-parametric statistical significance test

used to determine if there are associations between two variables (Weisstein, 2010). A significant association indicates that the relationship between the variables is likely to be non-random or due to chance. More traditional association tools, such as chi-square, could not be applied to this analysis because cross-tabulation cell counts were less than 5 in many instances. In such instances, Fisher's Exact Test allows us to analyze contingency tables regardless of cell counts or sample size. Fisher's returns a *p* value as a determinant of significance relative to a null hypothesis in this instance of an equally likely outcome in all categories. A two-tailed *p* value was used in this analysis.

Fisher's Exact Test is non-directional. In order to determine the magnitude and direction of the association, Somer's D was used. Somer's D tests the strength of association of cross-tabulated data when one variable is ordinal and the other is a nominal variable (Sheskin, 2007). Variables relating to sustainability policy, certifications, metrics, LCA, and carbon footprinting are two-point nominal variables (where 0 equals no participation and no plans for participation, and 1 equals participating or actively planning to participate). These will be cross-tabulated against influence variables that are ordinal in nature (values ranging from 0 equals no influence to 5 equals the highest influence). Somer's D returns a value ranging from -1 to 1, where -1 indicates 100% negative association (perfect disagreement), and 1 indicates 100% positive association (perfect agreement).

Results

The statistical analysis conducted on the relationship between firm size and practice of the four major sustainability practices is presented in Table 7. The results indicated a strong positive association between firm size and the presence of an official sustainability policy, the application of sustainability metrics, and the application of impact assessment as measured by LCA and carbon footprint (CF) participation rates. This suggests that larger firms may be better positioned to apply sustainability practices. However, there appears to be no significant association between firm size and participation in certification programs. The large variety of certifications available in the printing industry may allow firms of any size to participate.

Table 7. Somer's D values for significant associations between company size and sustainability practices

Practice	Company Size
Sustainability policy	0.409*
Certifications	-
Sustainability Metrics	0.473*
LCA	0.575*
CF	0.638*

Fisher's Exact Test 2x2 *p* values - No significant association

* $p < 0.05$

Conclusions

This survey explored the state of practice of sustainability measures within the printing industry in order to better understand the specific needs and challenges that need to be addressed to standardize the assessment of the environmental impacts of print. The main objective of this survey was to establish a baseline for the current state of adoption and implementation of sustainability practices within the printing industry.

The results of this survey should be interpreted with the limitations of the study in mind. These include a relatively large representation of:

- U.S. headquartered companies, though a significant number of respondents have operations outside the US,
- Companies with over 1,000 employees,
- Companies with commercial customers, and
- Companies that generate revenues from print production.

Lastly, it should be reiterated that these represent self-reported perspectives, and the largest function represented was management. However, with these caveats in mind, there are still some interesting observations that warrant further investigation.

Current State of Adoption of Sustainability Practices

From the analysis of the survey data, it is clear that there is a large amount of activity within the printing industry in regards to sustainable practices. However, it is also equally clear that much work remains to be done. An unexpectedly large fraction of respondents did not have a sustainability policy in place (27%). Of the companies with policies, almost all addressed environmental areas, while the majority addressed economic and social areas. However, the degree to which each of these areas was individually documented varied widely. This suggests that there is a need for a more consistent use and interpretation of the term "sustainability" within the industry.

With respect to metrics, a relatively large fraction of respondents (46%) were not actively developing sustainability-related metrics, while only 35% and 47% had reported activity on LCA and carbon footprinting, respectively. The lack of familiarity with some of the more well-known methods for quantifying environmental impacts and certifications programs (average response fraction of 63% and 40%, respectively) was surprising. If this fact is considered along with the fact that a majority of the metrics were being developed in-house, it creates a picture of a somewhat insular approach to sustainability metric development and use, with a high potential for inconsistency.

This issue becomes even more pressing when one looks at how the metrics are being used. While 34% of respondents did not report any influence on decision making, the

remaining fraction of respondents reported a relatively large influence on marketing/image-related decisions. This suggests that consumers are being given information from competing firms that is most likely being developed in an inconsistent manner.

These results call for a more detailed look at the processes and standards used to develop sustainability and environmental metrics in the printing industry. The researchers have conducted follow-up interviews with many of the survey respondents, and these interview results will be reported in a future working paper. In addition, another research monograph released in 2011, "Life Cycle Analysis in the Printing Industry – A Review" (PICRM-2011-05), takes an in-depth look at a range of publicly available assessment studies. However, one thing that was clear from the comments from the survey respondents, as well as the interviews and studies, was the need for unbiased, more standardized metrics, methods, and processes. This need will also be a focus of future research.

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Appendix A: Survey Questions

Q1. Do you participate in any of the following environmental certification or standards programs?

Program	Have not heard of it	Not planning to implement	Considering	Planning to implement	Implemented in some operations/ products	Implemented in all operations/ products
Sustainable Green Printing Partnership						
Forest Stewardship Council						
Sustainable Forestry Initiative						
ISO 14000						
LEED Certification						
Customer Required Certification						
Program for the Endorsement of Forest Certification						
The Natural Step						
Self Certification						
Other Programs						
Other (please specify)						

Q2. Does your company have a Sustainability Policy in place?

- Yes - Formal & Written
- Yes - Informal and Unwritten
- Currently in Development
- No
- Unsure

Q3. What areas are addressed in this policy? (Check all that apply)

- Environmental Performance
- Economic Performance
- Social Performance
- Other (please specify)

Q4. Does your company have a Corporate Social Responsibility Policy in place?

- It's part of our Sustainability Policy
- Yes - Formal & Written
- Yes - Informal and Unwritten
- Currently in Development
- No
- Unsure

Q5. Does your company have an Environmental Policy in place?

- It's part of our Sustainability Policy
- It's part of our CSR Policy
- Yes - Formal & Written
- Yes - Informal and Unwritten

- Currently in Development
- No
- Unsure

Q6. Has your company attempted to measure the overall sustainability of one or more of its products and/or services?

- Yes
- Under Development
- No
- Unsure

Q7. How are/were these sustainability metrics developed? (Select all that apply)

- Internal Effort
- Outside Consulting Company
- Academic University
- Other (please specify)

Q8. If you used outside resources in the development of sustainability metrics, please list the organizations and resources that you found the most useful in this process:

Q9. To what degree have the following factors influenced your approach to measuring sustainability of your products and processes?

Factor	1- Not at All	2	3	4	5	6 - To a Great Extent
Supplier Pressure						
Customer Pressure						
Regulatory Standards						
Company Image						
Our Competitor's Behavior						
Strategic Positioning						
Leadership's personal interest in sustainability						

Q10. Has your company attempted to measure the carbon footprint of one or more of its products and/or services?

- Yes
- Under Development
- No
- Unsure

Q11. How are/were these carbon footprint metrics developed? (Select all that apply)

- Internal
- Outside Consulting Company
- Academic University
- Other (please specify)

Q12. If you used outside resources in the development of carbon footprint metrics, please list the organizations and resources that you found the most useful in this process:

Q13. Has your company attempted to measure the total life cycle environmental impacts of one or more of its products and/or services?

- Yes
- Under Development
- No
- Unsure

Q14. How are/were these LCA metrics developed? (Select all that apply)

- Internal
- Outside Consulting Company
- Academic University
- Other (please specify)

Q15. If you used outside resources in the development of LCA metrics, please list the organizations and resources that you found the most useful in this process:

Q16. Please indicate if your firm has used the following methods to quantify the environmental impact of your products in your organization:

Method	Have not heard of it	Not planning to use	Considering	Planning	Use
Economic Input-Output Life Cycle Analysis					
Stream-lined LCA					
Sima-Pro					
Eco-Indicator					
Cambridge Engineering Selector (CES) Material Selector					
Embodied Energy Analysis					
Material Input per Unit of Service					
Ecological Footprint					
Thermodynamics and Flow Analysis					
Other (please specify)					

Q17. To what degree do the sustainability, carbon, and LCA measurements that you have identified influence decision-making in your organization?

Statement	1 - We do not measure any of these three items	2	3	4	5	6- To a great extent
Our measures of sustainability are an important part of our image and we want our customers and suppliers to be aware of our commitment to sustainability by showing actual changes in performance.						
Our measures of sustainability guide decision-making at the corporate/executive level						
Our measures of sustainability guide decision-making at the business unit/functional unit level (for example, supply chain, R&D, HR)						
Our measures of sustainability guide day-to-day decision-making at the implementation level (design decisions, supplier selection, etc.)						

Q18. What is the size of your company, including all locations? (number of employees)

- Under 20
- 20-99
- 100-249
- 250-999
- More than 1000

Q19. How many years have you worked for your organization?

- 1
- 2-5
- 5-10
- 10-20
- 21+

Q20. What is your function within your organization?

- Management
- Sales
- Support
- IT
- Accounting
- Creative
- Manufacturing
- Other

Q21. What is your job title?

Q22. Please estimate the percent revenue your company generates from the following areas of the Print Value Chain:

Area	0%-10%	10%-25%	25%-50%	50%-75%	75%-100%
Content Creation					
Workflow & Data Management					
Print Equipment Manufacturing					
Print Production					
Print Distribution					
Printer Services Consulting & Management					
End of Life Services (equipment remanufacturing, media recycling, etc.)					
Other (please specify)					

Q23. Please estimate what percent of your consumers are from the following markets:

Area	0%-10%	10%-25%	25%-50%	50%-75%	75%-100%
Consumer					
Office					
Commercial					
Packaging					
Government					
Other (please specify)					

Q24. Location of Headquarters:

- US
- Mexico
- SA
- Canada
- Europe
- Asia
- Other (please specify)

Q25. In what locations do you have operations? (Check all that apply)

- North America
- South and Central America
- Asia/Pacific
- Europe
- Middle East & Africa

Q26. What are the biggest difficulties in measuring and implementing sustainable practices?

Q27. As mentioned above, one of the goals of this survey is to identify companies for more in-depth follow-up research to generate best practices to benefit the entire print industry. Would you be willing to be contacted for a follow-up interview?

- Yes
- No

Q28. Would you be interested in learning about efforts to develop industry standards for measuring sustainability in the printing/communications industry?

- Yes
- No

Q29. Are you interested in receiving results of the survey?

- Yes
- No

Q30. If you answered yes to question 10, 11, or 12, please enter your contact information below. (NOTE: No individual company data will be reported, and survey data will be kept confidential. Providing this information is optional and will only be used if you answered yes to either questions 10 or 11.)

- Name
- Company Name
- Phone Number
- E-mail Address

Q31. Do you have any additional comments?

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