Developing capabilities for Sustainable Operations Management

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Abstract
Integrating sustainability in companies' agenda is a complex and multidisciplinary task. Based on the results of a survey conducted in 2015 with 106 respondents from manufacturing and infrastructure companies in Brazil, this research aims to verify the organization of a list of the main sustainable operations management capabilities that can provide companies with a path to achieve a higher level of maturity regarding sustainability integration. The research contributes by mitigating the lack of frameworks that seek alignment between operations with sustainability issues, helping to guide the strategy and to audit the level of sustainability integration.

Keywords: sustainable operations, maturity model, performance management, survey.

1. Introduction
According to Fahimnia et al. (2015), the integration of sustainability aspects in supply chain and operations management "(…) has been growing for at least 20 years and is welling to its third decade of investigation". This scenario requires a new configuration of the operations model, which should consider the impact of all the activities involved in its value chain, as confirmed by Ueda et al., 2009, KPMG, 2012, and Kiron et al. 2017.

Eccles et al. (2012) stated that what differentiates sustainable companies from traditional ones is the level of engagement from management, focusing on the needs of their stakeholders and collaborators, as well as incentive for innovation and continuous transformational change.

In this matter, companies need to identify best practices in all the activities in their value chains, some of which will be reflected in a more proactive approach to address and mitigate problems, enabling competitive advantages and creating economic, environmental, and social value. For this research, best practices are represented by the word "capability", which according to Wißotzki (2015) can be represented by resources, business context, goals, processes, knowledge, and role.

According to Kiron et al., 2017, reporting results from a global survey with more than 60,000 respondents, even though a majority of companies are considering sustainability as relevant to competitiveness, there is a gap between sustainability vision and action, as well as that a lack of a model for incorporating sustainability".

Veleva et al. (2001) graded an organization progress in the sustainability context from one degree of maturity to the next following a model based on total quality management; as a result, its behavior should progress according to its responsibility to nature and society in general. Dao et al. (2011) described the SOM maturity through the evolution and continuous evaluation of organizational resources and skills.

For over 30 years, Silvius and Schipper (2010) and van Looy et al. (2013) recognize that companies have used maturity models as an instrument for improvement and development of capabilities in complex environments. According to Fraser et al. (2002) and Tesmer et al. (2011), maturity models help to describe a company's behavior more objectively and simply, identifying sets of best practices, providing direction on how and where to start improvement processes. In this matter, Pinheiro de Lima et al. (2012) found that maturity models also have contributed to the development of capabilities related to SOM and a trajectory could be traced for a company and their operations networks.

Considering this context, the research question arises: which sustainable operations' capabilities are relevant for a company to manage in order to achieve a higher maturity level in implementing sustainability? Based on a survey, conducted in Brazil during 2015, this research aims to verify the organization of SOM capabilities to achieve a higher level of maturity for sustainable operations management and the level of implementation of these practices in 106 companies with operations in Brazil.

2. A Maturity Framework for Sustainable Operations

Nascimento et al. (2013) synthesized the concept of maturity into three perspectives applied by this research: *Maturity* - moving from an early stage to an advanced stage over time, as presented by Sousa and Voss, 2001; *Capability* - full development or a perfect condition for a process or activity, as described by SEI, 2010; and *Evolution* - whereby a process may go through intermediate stages until it reaches maturity, as stated by Lahti et al., 2009.

In an earlier research stage, Machado et al. (2017) organize a sustainable operations maturity framework based on the literature, case studies, and contributions from experts. According to the authors, the maturity of SOM can be understood as a sequence of capability improvement levels that enable the company to conduct its operations more sustainably. Five evolutionary levels define the "content" of maturity according to the

sustainable operations management theory (Figure 1) representing an evolving and cumulative process of practices and experiences that propel a company to seek standards of excellence in operations with a focus on long-term gains, innovation, and continuous improvement, following inputs from the literature such as Veleva et al., 2001, Johansson and Winroth (2010) and Dao et al. (2011).

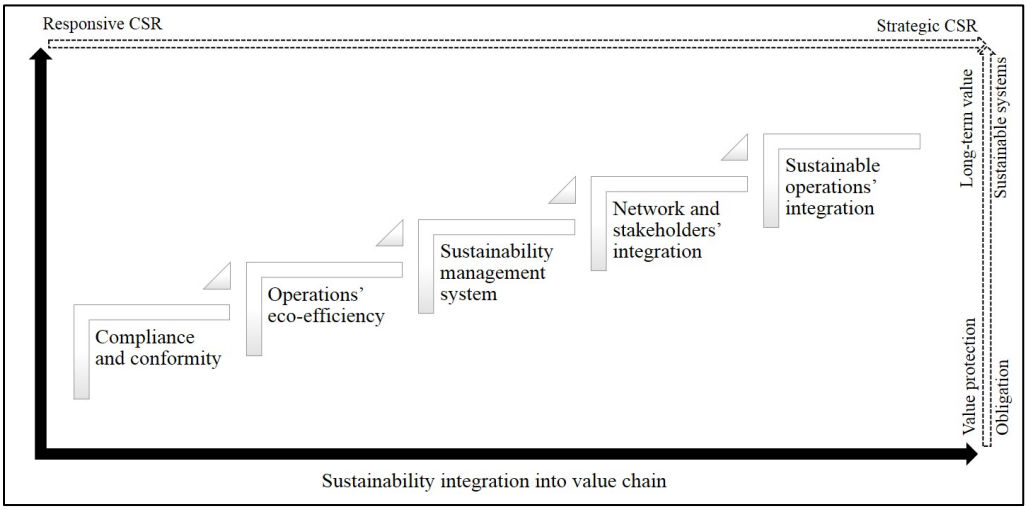

Figure 1– Maturity levels for sustainable operations management

The maturity framework organizes the capabilities that must be guided by a business model and a corporative strategy that supports the dissemination of the meaning of sustainability and strategies throughout the company and its value chain. In this matter, the previous research also identified the most relevant SOM capabilities related to each maturity level (see Table 1) viewed as complementary processes, which can be deployed and managed in an integrated manner: **Group 1:** *Sustainable Life-Cycle Product Management* – Life Cycle Assessment (LCA); Design for Sustainability (D4S); Reverse Logistics and Closed Loop Supply Chain (CLSC); **Group 2:** *Sustainable Production* - Lean and green process, Sustainable Purchasing, Eco-efficiency, Cleaner Production (CP), Quality and Environmental Management Systems (QMS/EMS); **Group 3:** *Social Responsibility and Accountability* – Organizational Health & Safety (OH&S), Social Accountability and Sustainability Business Case (SBC); **Group 4:** *Value-chain integration* - Suppliers Development Program (SDP); Stakeholder Engagement; Information System (IS); **Group 5:** *Corporate Social Responsibility* - SBC; Sustainable Marketing.

Table 1– Main SOM capabilities context for each maturity level

1	**Group 3** - Company starts recognizing its obligations and responsibilities. Social Accountability directly encompasses compliance with regulations connected to environmental licenses, workers' employment and OH&S. Also includes strong rules to combat gender discrimination and forced/slave labor while providing liberty of association and human and children rights. Company has procedures to assess and combat corruption and unfair practices in all operations within its value chain. Impacts and opportunities for local development of communities are assessed. Through sustainable business cases, identify how compliance & conformity can add value to business, while reducing environmental impacts and benefiting society.

Table 1– Main SOM capabilities context for each maturity level (cont.)

2	**Group 1 -** Sustainability is integrated through product design and implementation of a CLSC and RL strategies. Processes related to life cycle assessment (LCA) are used to identify and reduce environmental impacts in products, enabling reuse/ recycling, and/or projects conducted together with partners to build infrastructure that guarantees reuse/recycling beyond the standard streams, supported by RL systems.
3	**Group 2 -** Sustainability is integrated through processes formalization for sustainable production based on the integration of the QMS and EMS. Eco-efficiency and CP approaches, supported by lean and green operations, guide changes/innovations in the production in order to improve the sustainability performance across value chain operations, reducing environmental impacts and resource consumption during manufacturing processes. This new pattern of production requires new rules & policies for purchasing, including not only economic variables (e.g. price, quality), but also environmental and social ones in the processes of selection of suppliers, materials and services, improving the sustainability footprint.
4	**Group 4 -** Suppliers, customers, and other stakeholders engage and corroborate on sustainability strategies and operations. Company and suppliers share information about demand planning, transport, production, integrated performance data, and knowledge enabling supplier's involvement in redesigning the company's internal processes. Suppliers are encouraged to be aligned with global sustainable development initiatives. Regarding customers, the upper-level administration considers sharing information with customers to be fundamental, and supports activities and processes related to this practice.
5	**Group 5 -** IS support a new business model aligned with sustainability principles, which integrate internally QMS, EMS & Social management systems, and externally the supply chain management and other stakeholders, creating a wide sustainability net. Sustainable marketing strategies are developed to support value chain integration, to identify customers expectations and regulatory requirements for product development, define a sustainable products portfolio, and report sustainability results to all stakeholders and society.

Presented the theory background, it is possible to conceive a research planning.

3. Research Design

This research considers the guidelines in the models by Forza (2002) and Melnyk et al. (2012) and has exploratory characteristics as research on maturity in sustainable operations management is in the early stages (Forza, 2002, Machado et al., 2012). More broadly, it can also be classified as descriptive survey research, focusing on understanding the relevance and patterns of sustainability management and describing how companies are adopting sustainability capabilities.

Qualtrics© software was chosen for providing the questionnaire, collating the data, and conducting the initial statistical analysis. According to Klassen and Jacobs (2001), alternative research technologies, including Web pages, have presented good results, and also have lower application costs and tolerate lower rates of response.

3.1 Sample and Questionnaire

The online survey was emailed to professionals working in manufacturing (e.g., automobile), and infrastructure companies (e.g. civil construction) from various sectors (see Figure 2). The first wave of survey (n=314) was sent to professionals from companies directly aligned with the research context and identified by a set of

characteristics. Second wave was sent to a wider sample (n=884), comprised by: professionals with managerial position and companies' scope, and other ones from education programs - Lean Logistics, Lean Manufacturing, Lean HealthCare, Lean Six Sigma, Production Engineering, Quality and Project Management.

Strategies adopted to improve response rate and the quality of the answers were: subject interest (appropriate and/or interested manager); pre-notice (a brief advance letter or phone call); messages to each person by name, with a personalized survey link; contact information; multiple mailings (i.e. multiple waves); appeals (sincere requests for help); steady pressure (periodic reminders by phone and/or mail). In total, 106 questionnaires were considered completed performing a response rate of 9%.

The questionnaire was developed in two blocks: (1) formed by 16 questions related to the companies' contexts and respondent characteristics (e.g. job position, level of knowledge about sustainability, company's sector, sustainability in the strategy and how long, management systems, etc.); (2) 93 statements associated with SOM practices/process or to sustainable business models. Questions and statements were developed based on previous tested sustainability surveys/questionnaires, including: Schroeder; Flynn, 2001; Hannaes et al., 2011; Brandt et al., 2011; Kiron et al., 2012, 2013a,b; and, EFQM, 2010.

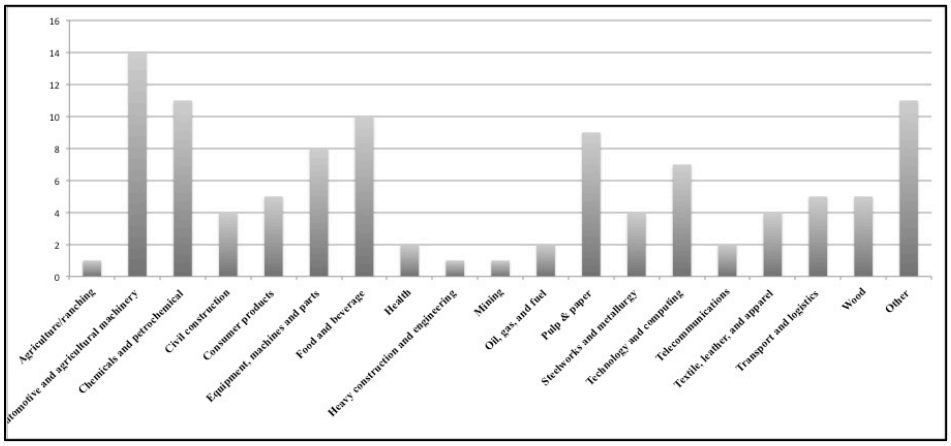

Figure 2 – Respondent companies' sectors

An unbalanced and itemized six-point Likert-type scale was used to evaluate the level of adoption/implementation related to each statement: **(0) Non-existent**: total lack; **(1) Initial:** only potential approaches have been identified and applied in isolated situations; (2) Managed or repeated: process, area, or activity implemented by project, and repeated in similar applications; **(3) Defined**: process, area, or activity integrated into the organization's processes; **(4) Quantitatively managed:** systematized process, area, or activity, measured and managed based on continuous improvement; **(5) Optimizing:** process, area, or activity considered to be at best-practice level.

3.2 Pre-test and statistical analysis

A pre-test was conducted with a heterogeneous sample comprised of professionals in continuing education courses and companies that had participated in earlier stages of the research (n ≈150). In all, 42 questionnaires were returned (28%), but only 20 (13%) were

considered valid (i.e., were fully answered). Internal consistency was tested and considered acceptable by the Cronbach's alpha coefficient, following guidelines from Field, 2010. Cronbach's α for each block of statements are: Corp. Strategy – 18 statements (.987); Group 1 – 16 statements (.926); Group 2 – 18 statements (.924); Group 3 – 4 statements (.683), Group 4 – 12 statements (.885); Group 5 – 4 statements (.685).

The lower rates in Groups 3 and 5 have been attributed to the low number of items evaluated. This factor was improved when the final questionnaire was compiled. However, as the results were close to the value indicated as acceptable by the literature (0.70), they were also considered acceptable for the pre-test.

Pre-test also pointed out the need for further improvements in the questionnaires, such as reordering/reallocating questions, removing redundant items, and providing more information about the contents of each block of items to be evaluated. The results also indicated that there could be difficulties in obtaining a significant return, given the broad scope of the questionnaire and of the topic of "sustainability," which is still considered incipient by some companies. To mitigate this issue respondents were informed that they could answer the questionnaire in stages and that their data would be automatically saved.

Following Field (2010) model, data analysis encompassed: (1) cross-tabulation tables using Excel in order to evaluate and identify possible patterns of behavior among the cases; (2) testing correlation between the statements' group through the Spearman coefficient, which does not depend on assumptions of a parametric test; (3) clustering was carried out using Ward's Hierarchical Clustering Model with Euclidean distance, according to Hair (2005), provides good results for both Euclidean distances as well as for other distances and tends to combine clusters with few elements.

4. Findings and discussions

The reliability of each block of statements was considered satisfactory according to Cronbach's *α.* Cronbach's α for each block of statements are: *Corp. Strategy* – 15 statements (.980); *Group 1* – 15 statements (.977); *Group 2* – 23 statements (.975); *Group 3* – 14 statements (.962), *Group 4* – 13 statements (.956); *Group 5* – 13 statements (.973). Each block was also correlated (Spearman's coefficient), with the presence or absent of sustainability in companies' strategies, results pointed out that when sustainability is part of the company's strategy, the scope, level of implementation, and maturity of the SOM capabilities tend to be higher.

About respondents' characterization, Table 2 highlights some relevant results that can be related to Stoughton and Ludema (2013), which affirms "[…] middle managers were "catalytic" for bringing sustainability into their organizations […]".

Table 2 – Summary of respondent characterization/qualification

Have a managerial position	41%
Have an operational/technical position	53%
Have a position related to sustainability	66%
Have been working up to 10 years in this position or related function	53%
Expert/leader in this subject	22%
Some knowledge, but not expert	59%
Fully informed about the sustainability strategies of their companies.	46%
A bit informed about the sustainability strategies of their companies	40%

In terms of the companies' characteristics, 73% (*n*=77) of the respondents stated that sustainability is embedded in their business' strategic agenda, 37% in the last five years and 28% up to10 years. Overall, the results also indicate that 52% are headquarters (*n*=64 in Brazil) and 41% subsidiary. About the size, 31% have 50 – 200 employees, 55% have 200 – 10,000, and 12% have 10,000 – 100,000 employees. Regarding management systems, Table 3 presents a summary of the results.

Table 3 – Management Systems

	Yes*	No*		Yes*	No*
QMS	68	20	*Energy Management*	17	1
EMS	61	9	*Life Cycle Management*	17	1
OH&S	53	6	*Corp. Governance*	22	3
Social Responsibility	30	5	*Information Technology*	19	6

*Sustainability in the strategic agenda (*n*=)

Table 6 shows that companies, which claim to have sustainability embedded in the strategy, tend to have implemented management systems related to the three dimensions of sustainability, including corporate governance. These characteristics are more evident in larger companies, however in cases stating that sustainability is not part of the strategy, in general smaller, at least one aspect of sustainability is being treated by their management systems, in general in order to attend business requirements through certifications (e.g. ISO 9001, ISO 14000 or OHSAS 18001).

Analysis of the boxplot graph Figure 3 indicates that, for most respondents who claim that sustainability is part of the company's strategy (*n*=77), corporate strategies and practices/processes related to SOM are been described as 'Defined' and 'Quantitatively Managed'. In cases where sustainability is not considered part of the company's strategy, SOM practices, in general, are being implemented ad hoc and in a reactive approach, confirming the global results from Kiron et al. (2017). Practices related to social accountability, Organizational Health & Safety (OH&S), and sustainable marketing present a higher level of maturity of implementation, confirming the difference, pointed out by Eccles et al. (2012), between sustainable and traditional companies.

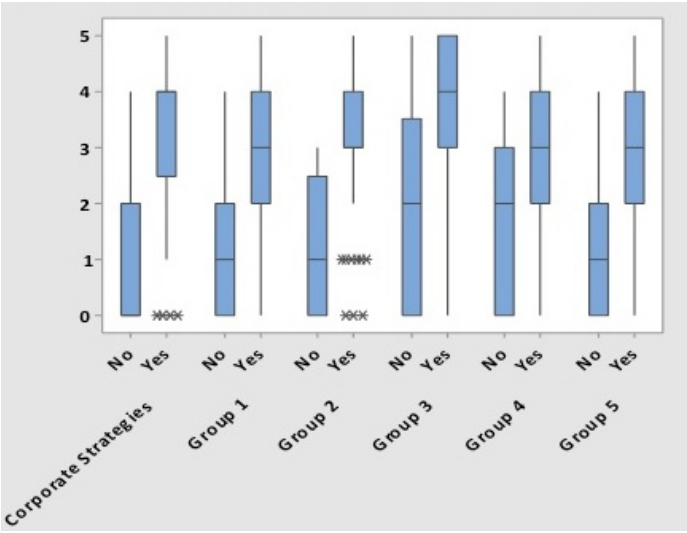

Figure 3 – Boxplot

When asked to describe the focus of the sustainability integration into company's strategies the 3, by the respondents, most cited words are: Compliance (n=23); Innovation (n=20); and, Management Systems (QMS, EMS, OH&S) (n=7). Results allow us to infer that compliance focus drives sustainability implementation, followed by innovation for sustainable production (most of practices focused on reducing the use of materials and waste), and by the implementation/certification of management systems, following the findings presented by Cagliano (2015).

Cluster analysis was performed from 2 to 5 groups in order to evaluate them. Table 4 presents the five clusters formed by the variables to SOM practices and processes. Clusters' results were crossed with the main capabilities' groups organized in the previous research by specialists and the organization of the main capabilities was confirmed. Results are listed in Table 5.

Table 4 – Sustainable Operations Practices' Clusters

Cluster	Statements Grouped
1	Q19.1, Q20.3, Q20.6, Q20.7, Q20.8, Q20.9, Q20.10, Q20.11, Q20.12, Q20.13, Q20.15, Q20.16, Q20.17, Q20.18, Q20.19, Q20.20, Q20.21, Q20.22, Q20.23, Q21.5
	Related capabilities: RL, lean and green processes, CP, sustainable purchasing, social accountability, QMS, and eco-efficiency.
2	Q19.2, Q19.3, Q19.4, Q19.5, Q19.6, Q19.7, Q19.8, Q19.9, Q19.10, Q19.11, Q19.12, Q19.13, Q19.14, Q19.15, Q20.1, Q20.2, Q20.4, Q20.5, Q20.14
	Related capabilities: LCA, RL, D4S, CLSC, CP, EMS, eco-efficiency, and SBC
3	Q21.1, Q21.4, Q21.6, Q21.10, Q21.11, Q21.12, Q21.13, Q21.14, Q22.1, Q23.4, Q23.5, Q23.8, Q23.9, Q23.10, Q23.12, Q23.13
	Related capabilities: sustainable purchasing, social accountability, and SDP.
4	Q21.2, Q21.3, Q21.7, Q21.8, Q21.9, Q22.3, Q22.4, Q22.5, Q22.7, Q22.13, Q23.1, Q23.2, Q23.3, Q23.6, Q23.7, Q23.11
	Related capabilities: social accountability, OH&S, SBC, sustainable marketing, information system, SDP, and stakeholder engagement.
5	Q22.2, Q22.6, Q22.8, Q22.9, Q22.1, Q22.11, Q22.12
	Related capabilities: SDP, information system, and stakeholder engagement.

Table 5 – Adherence of the main SOM capabilities with clusters

	Main SOM capabilities' grouped by experts	Cluster	Maturity level
1	LCA; D4S; RL; CLSC	2	2
2	Lean and green; Sustainable Purchasing; Eco-efficiency; CP; QMS; EMS	1	3
3	OH&S; Social accountability; SBC	4 and partially on 3	1
4	SDP; Stakeholder Engagement; IS	5	5
5	SBC; Sustainable Marketing	4	4

Thus, the presented analysis allows us to infer that the implementation of SOM capabilities, as described in Table 1, can contribute to sustainability integration into the strategy and support its evolution. It is clear that the maturity of a sustainable operations management is a cumulative and nonlinear process and sometimes process/practices can also be overlapping.

5 Conclusion

The research question was answered considering that the goal of this research was to identify a list of SOM capabilities that companies can prioritize in order to moving forward in the sustainability integration, in other words, sustainable operations management can become a core competence of the organization and, as such, a driver of business strategy rather than merely the vehicle for its implementation, as stated by Bettley and Burnley (2008). It is important to highlight that besides the capabilities listed in Table 5, there are more SOM capabilities related to each maturity level (as listed in Table 4), future research could dedicate efforts to verify their organization through deep case studies.

Results (e.g. Boxplot) also indicate the acceptability and reliability of the maturity levels proposed in Figure 1. The research's limitations include: the sample size; the average time spent to complete the questionnaire - considered too long; the difficulty of identifying the professionals in each company; some firms' policies to not participate in surveys; some companies' position on refusal to discuss sustainability since it seems to be a strategic topic. Even so, it is worth noting that, in general, respondents praised the questionnaire's scope. In this matter, the results generated by the cross-tabulation tables were considered relevant for defining the respondents' characterization and qualification.

Results also contribute to studies on SOM by helping to reduce gaps concerning the models and frameworks for supporting SOM strategies and by helping companies incorporate sustainability. Future researchers also can dedicate efforts to a more comprehensive analysis connected with the maturity of SOM capabilities and also how the technologies can support sustainable operations implementation and development.

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