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A Framework for Integrating Sustainability Themes into Global Value Chain Coursework of an Industrial Technology Management Program

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SUBMITTED FOR *PEER – REFEREED*

A Framework for Integrating Sustainability Themes into Global Value Chain Coursework of an Industrial Technology Management Program

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Abstract

Over the past decade, there has been a shift in corporate commitment toward embracing sustainability as a core value. Companies are rapidly developing guiding principles and implementing strategic initiatives to meet regulatory requirements, satisfy customer demands, augment company reputation, solicit business opportunities, compete for financial investment, and preserve the earth's environment and resources for future generations. To achieve these goals, management and leadership of the environmental, economic, and societal dimensions of an enterprise's operations are critical. The value chain, which consists of primary and supporting supply chain activities, has been identified as a major area for sustainability action by organizations such as the United Nations Global Compact, international regulatory bodies, and multinational corporations. While mandatory reporting is not required in every country, companies conducting global business will face increasing pressure to embrace sustainability values as trading partners around the world demand compliance with national and regional regulations. Even without regulatory constraints, companies will continue to implement improvements to reduce operational costs, strengthen competitive advantage, and raise corporate perception ratings through metrics such as sustainability indices.

These trends point to a need for students in industrial technology management programs, who take value chain coursework, to gain deeper insight into the analysis, leadership, and management of sustainability initiatives to prepare them for future roles in the workforce. However, a literature review on the topic indicates a dearth of articles pertaining to the type and level of sustainability content required in industrial technology management programs to prepare students for these future roles. This paper presents a framework for integrating sustainability concepts into value chain coursework to engage students in thinking more deeply about sustainability issues. Using the example of an industrial distribution and logistics curriculum, content is recommended and Bloom's taxonomy is applied to suggest evaluation approaches. The paper provides a guide for academics who wish to incorporate sustainability as a continuous theme with a global perspective in value chain coursework of industrial technology management programs.

Introduction

With the rapid increase in momentum of the sustainability movement, the need to integrate sustainability content into university curricula is increasingly being advocated (Engle et al., 2016), as candidates entering the workforce with sustainability skills are considered to be an asset (Lonzano et al., 2015). This rationale for a sustainability agenda stems from the United Nations' 17 sustainable development goals (SDGs), which are considered to be the authoritative guide on the global sustainability challenge (Thorlakson et al., 2018). However, studies indicate that despite the progress being made along sustainability lines, global value chains have not yet achieved their full potential in integrating the SDGs into their operations (Bonini et al., 2010; Thorlakson et al, 2018). One problem cited is the shortage of technical and managerial talent to meet the sustainability needs of stakeholders (Dubey and Gunasekaran, 2015; Strandberg, 2015). Both specific technical and management skills and broader systemic thinking skills (Zamora-Polo et al., 2019) have been identified as essential for approaching sustainability problems holistically (Strandberg, 2015) and for better managing sustainability risk and opportunity (Williams et al., 2017).

One way that this shortage could be addressed is by integrating sustainability more broadly and deeply into the curricula of university programs. Industrial technology management curricula, which include both technical and management courses pertaining to the value chain, are in a prime position to incorporate sustainability content into coursework to address the needs of stakeholders. However, a review

of popular textbooks used for teaching coursework related to the primary and supporting activities of the value chain indicates that there is limited content and application in the area of sustainability. To this end, this paper proposes a framework for integrating sustainability content into an industrial technology management program. The paper provides a guide for academics interested in incorporating a continuous sustainability theme into programmatic coursework to prepare future leaders to meet workforce requirements.

Background

Over the past decade, there has been a rapid shift in corporate commitment toward embracing sustainability as a core strategic value, as companies realize that future survival of the firm depends on taking a different perspective on the meaning of corporate responsibility. This new agenda is being spearheaded from the highest levels of management. The Business Roundtable, a non-profit organization comprised exclusively of Chief Executive Officers (CEOs), recently redefined the purpose of a corporation from existing to meet the goals of shareholders to operating for the full benefit of all stakeholders (The Business Roundtable, 2019). Commitment to this changing role was endorsed by over 95% of the 188 CEO members of the Business Roundtable (Benoit, 2019). This will, no doubt, have profound implications for managing the operations of a corporation to generate financial value for shareholders, while simultaneously benefiting employees, supply chain participants, communities, and the environment (The Business Roundtable, 2019).

The concept of sustainable development itself is not new, having been defined since 1987, in a report entitled Our Common Future, as "the ability to meet the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987). The report underscores the growing tension in the symbiotic relationships of stakeholders in the global environment and describes sustainable development as an ongoing iterative process in which current decisions on resources, investments, and technology must be balanced against future needs (WCED, 1987). Consequent to this awakening, the Triple Bottom Line (TBL) accounting framework was developed to facilitate measurement and reporting of the value created through economic, environmental, and social investments (Elkington, 1998).

These initiatives, along with the United Nations sustainable development goals (SDGs), ethical demands of non-governmental organizations (NGOs) and community groups, changing values of consumers and stakeholders in society, and development of legislative instruments, regulatory guidelines, and sustainability performance indices by national governments, standards bodies, and stock exchanges, have increased the pressure on corporations to adopt sustainable practices in their operations. Specifically, supply chains have been identified by international organizations, such as the United Nations Global Compact and others (UN Global Compact Office and BSR, 2015; Thorlakson et al., 2018), as an area for sustainability action because of the critical role supply chain activities play in the creation of corporate value. Eighty percent of global trade is attributed to the supply chains of multinational corporations (Thorlakson et al., 2018). In 2017, the United States alone had a combined import and export merchandise trade with its top five trading partners – the European Union, Canada, Mexico, China, and Japan – that exceeded US$2.7 trillion (WTO, 2019). Concurrent with the design of sustainable supply chains, the design of sustainable products is also recognized as being necessary to minimize the environmental impact over the product lifecycle from concept to disposal.

Given these statistics, the urgency to achieve the SDGs in a global context becomes clearer. To lead and manage a sustainable supply chain, a new set of skills beyond economic principles is required (Dubey and Gunasekaran, 2015). This need is apparent from a recent study on how publicly listed global companies are addressing the sustainability challenge in their operations. Among various issues, the study notes that sustainable sourcing continues to focus on mitigating risks associated with compliance and workers' rights but ignores other sustainable development goals (SDGs) that can have a significant environmental and social impact (Thorlakson et al., 2018). To address the topic of sustainability and the associated issues of complexity, uncertainty, emergence, collaboration, long term planning, resilience, and tradeoffs to improve innovation and overall firm performance, a holistic perspective (Boiral et al., 2014; Isaksson et al., 2010) that underscores the importance of systemic thinking (Isakson et al., 2014) is required.

With regard to sustainability, however, the supply chain is better discussed from a value chain perspective. While some scholars (Christopher, 2016; Coyle et al., 2017) recognize that the supply chain is transitioning into the broader value chain concept, it is important to point out that the traditional supply chain definition focuses on an integrated system of enterprise flows of goods, information, and finances from original supplier to final customer (Lambert et al., 2014) and is not driven by the value perceptions of the customer. Yet, when consideration is given to the forces of global change that influence sustainability action, the demands of end customers and other stakeholders cannot be ignored. Porter's generic value chain is the de facto guide on value-creating activities at the organization level. Along with the supply chain activities of manufacturing and distribution, it includes activities, such as product and process innovation, financing and planning of infrastructure, and marketing, that provide an opportunity to align operations to the voice of the customer (ISC HBS, 2018). All of these disciplines, to some extent, fit within an industrial technology management curriculum, which takes both a practical and cross-sectional view of value chain activities.

While corporations are beginning to develop comprehensive guidelines to address this new management paradigm, the regulatory mechanism to force sustainability action is being built simultaneously.

In 2016, the Global Reporting Initiative (GRI, 2016), a United Nations affiliate, released a new set of modular standards on sustainability, replacing the G4 standards used globally for voluntary sustainability reporting (Merrill, 2016). In July 2018, reporting in accordance with the new GRI standards became mandatory for large public corporations in the European Union (EU), in support of the Directive 2014/95/EU legislation (European Commission, 2018), which requires public companies with over 500 employees to disclose current and likely impacts of operations on the environment, society, and economy. These requirements have implications, not only for EU corporations, but also for companies that insert into their global value chains.

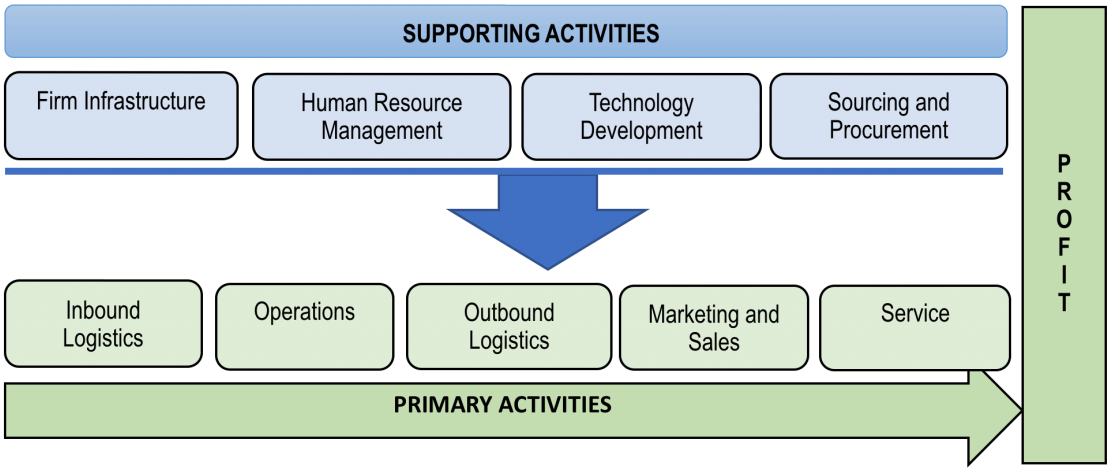

Figure 1: A Depiction of Porter's Generic Value Chain

This growing sustainability trend is supported by a study (KPMG, 2017) in which the national rates of corporate responsibility reporting, based on mandatory and voluntary requirements of governments and stock exchanges, were noted to be 90% or higher in the United Kingdom, Japan, India, Malaysia, France, Denmark, South Africa, the United States, and Mexico. For example, the Mexican Stock Exchange has created a sustainability index that encourages timely and accurate disclosure of issues pertaining to governance, social responsibility, and the environment (Solley, 2016). In the USA, the Securities and Exchange Commission (SEC) requires a company to disclose all material issues that have the potential to impact an investor's decision (Merrill, 2016). While two of the USA's top five trading partners, Canada and China, are lagging behind, they too are making progress toward the goals (Bohr, 2016; Sino-Swedish CSR, 2017). Thus, even in the absence of legal or regulatory frameworks, it will be important for companies to embed sustainability in their operations to be competitive global value chain participants. To meet this imperative, organizations are developing guiding principles and implementing initiatives to comply with regulatory requirements, create new products, augment company reputation, solicit busi-

ness opportunities, compete for financial investment, and preserve the earth's environment for future generations.

However, achieving such transformational change requires sustainability education to be revamped (Boons et al., 2013) to draw attention to the myriad issues, impacts, and interconnections of activities that can exist over time. Hess and Maki (2019) note that a college education devoid of sustainability content is inadequate to advance the environmental sustainability agenda, as belief in such an agenda is shaped by the exposure to sustainability coursework, as well as other values and environmental influences (Hess and Maki, 2019). Furthermore, when considering the stages of sustainability maturity of a firm from compliance, to efficiency, and finally, innovation (Miller and Serafeim, 2014), the ability to explain, analyze, evaluate, and synthesize the risks and opportunities associated with each stage is essential. To develop the appropriate skills to lead and manage such efforts, coursework and assignments that stimulate different levels of thinking, from recall of facts to creation of new and innovative ways to integrate sustainability into the value chain, are essential in the curricula of industrial technology management programs.

Literature Review

Various authors have addressed the sustainability talent shortage by examining the issue of sustainability content in higher education course curricula to increase student competencies for future leadership and management roles. A review of the literature indicates that the majority of these studies pertain to sustainability content in sustainability, business, and engineering curricula.

O'Byrne et al. (2015) reviewed 54 undergraduate and master's programs in sustainability, environmental science, and sustainable development. They found a lack of consistency in the sustainability content among similar programs (O'Byrne et al., 2015).

Tejedor et al. (2019) conducted a study to identify research trends in the area of sustainability in an effort to align curricula content to the learning outcomes of engineering programs. The authors were able to identify three research streams that focused on (i) institutional requirements and policies regarding sustainability in higher education curricula; (ii) pedagogical approaches to develop faculty for sustainability education; and (iii) sustainability topics that transcend single disciplines (Tejedor et al., 2019). Zamora-Polo et al. (2019) conducted a survey using a validated instrument to assess the sustainability knowledge of university students, by gender, and across the disciplines of health, education, and engineering. The results indicated that deficiencies in sustainability content needed to be addressed to progressively build specific and systemic competencies (Zamora-Polo et al., 2019). Akeel et al. (2019) evaluated the sustainability literacy of Nigerian engineering students, faculty, and professionals to gauge awareness of the United Nations Decade of Education for Sustainable Development. Their findings indicated unawareness of this initiative, suggesting the need for improving sustainability articulacy through greater educational resourcefulness (Akeel et al., 2019). Garbie (2017) looked at the feasibility of incorporating sustainability content in industrial systems design courses.

Gramatakos and Lavau (2019) conducted an inductive and qualitative inquiry to understand how student-led experiences at a higher education institution in Australia promoted more meaningful sustainability learning. From the study, they were able to develop a typology of informal campus opportunities that have the potential to impact the cognitive, practical, and affective learning areas with regard to sustainability. Brundiers and Wiek (2010) proposed a new vision for sustainability education by developing a framework to incorporate real world projects into the sustainability content of curricula.

Remington-Doucette et al. (2013) evaluated the development of systems thinking skills of university students studying business; sustainability; and an alternative major with a sustainability minor. The goal of the study was to suggest how sustainability could be integrated into the different academic programs to build systems thinking competencies. America (2014) conducted an exploratory study to measure the impact of supply chain sustainability concepts on the systems thinking skills of three groups of business education students in bachelor's degree programs at three universities. The study focused on understanding how students analyzed and synthesized sustainability information and extended the

thinking beyond the basic definitions and explanations of supply chain activities. The aim of the study was to help business education teachers draw out more meaningful discussions on the broader impact of supply chain activities and interrelationships on environmental and social eco-systems. Hughes et al. (2018) discussed a conceptual approach for integrating sustainability into business school curricula to prepare business students for corporate management roles where environmental, social, and economic results need to be balanced. Chen et al. (2018) conducted a study to match industry requirements to sustainability content in business school coursework. The authors conducted interviews with professionals in industry from which 52 topics were identified and clustered into five main groupings and further categorized by importance and difficulty. The aim of this study was to facilitate the development of a sequence of sustainability courses. While the study provided a useful approach for matching industry sustainability requirements to university-level business coursework, the shortcomings included the lack of specificity in identifying areas in which distinct topics could be incorporated and the absence of suggested assignments to meet required cognitive development levels.

There are several more cases where attempts have been made to identify and recommend sustainability content for inclusion in university course curricula. Readers are referred to the works of Hasna (2010), Rusinko (2010), Aurandt and Butler (2011), Doh and Tashman (2012), Dickson et al. (2013), Sidiropoulos (2014), Zabinski et al. (2015), Figueiro and Raufflet (2015), and Thürer et al. (2018) for further information on the topic.

After reviewing the literature, one area relating to the preparation of future leaders for sustainability roles in the value chain does not appear to have been addressed. To the best of the author's knowledge, the literature does not include (i) a detailed analysis of stakeholder requirements, coded based on cognitive learning levels, to facilitate the development of sustainability content for industrial technology management coursework, or (ii) an analysis of how well current textbooks with value chain management content meet stakeholder sustainability expectations. To address this gap, this study proposes to do the following:

(1) Conduct a thorough examination of the sustainability literature to identify key stakeholders and their sustainability-related requirements.
(2) Assess stakeholder requirements and categorize the same by coding using Bloom's taxonomic hierarchy to match desired outcomes to appropriate levels of cognitive thinking.
(3) Review the sustainability content of leading textbooks that cover value chain activities and code content and assignments using Bloom's Taxonomy.
(4) Conduct a gap analysis by comparing stakeholder sustainability requirements to textbook sustainability content to identify where supplementary content is required.
(5) Provide examples of sustainability-related assignments to fill the identified gaps.

Methodology

The methodology used for this study is a qualitative inquiry based on a content analysis. Through an inductive process, various documents and data sources were read and examined to identify patterns and consistencies that provide a deeper understanding of the area of interest. This method is appropriate when the research is exploratory in nature and is intended to gain insight into an emerging or little understood topic (Creswell, 1994) to reach a conclusion from a set of details (Dudovskiy, 2019). Unlike quantitative research, which utilizes tools such as surveys to gather data, the researcher is the actual tool used to gather the data in a qualitative study (Creswell, 1994). Data collection is achieved through observation and examination of relevant information sources. The researcher is also directly involved in analyzing and summarizing the unstructured data collected using an interpretative approach based on a systematic process of coding and categorization into distinct and meaningful themes that reduce the data into manageable pieces.

Given the fact that the sustainability agenda is evolving and a need exists to gain deeper insight into the driving forces, performance expectations, and initiatives of organizations to support the development of a body of knowledge that meets emerging needs, the use of a qualitative research method is an appropriate approach for this study. Figure 2 provides a schematic of the methodology used and is followed by a detailed description of the data collection and analysis process.

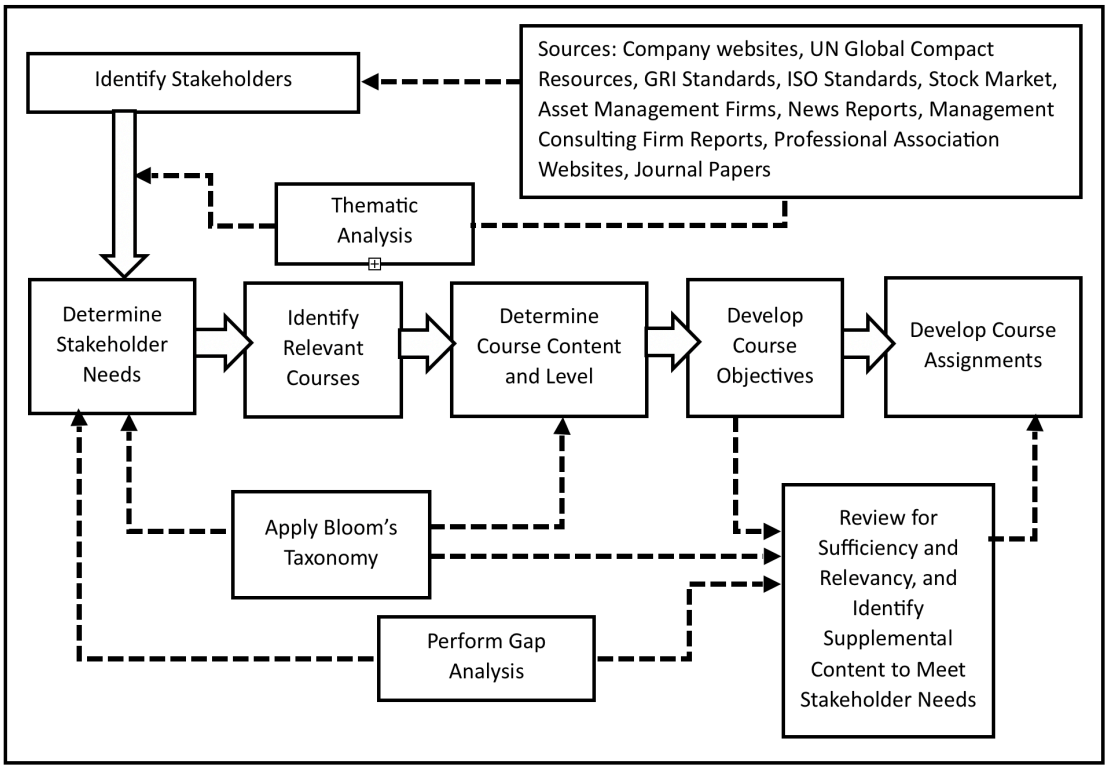

Figure 2: Methodology of Study

Step 1: Sustainability Requirements of Stakeholders of Global Value Chains

To understand the requirements to lead and manage global value chain sustainability efforts, the first step is to determine the stakeholders of value chains and their minimum sustainability requirements (Engle et al., 2016). To gain this perspective, an inductive qualitative analysis was performed by analyzing the content of leading sustainability resources, e.g., the United Nations (UN) Global Compact website, the UN report on Investor Needs in Business Reporting on Sustainable Development Goals (SDGs), Supply Chain Sustainability – A Practical Guide for Continuous Improvement, the GRI 2016 Sustainability Reporting Standards, ISO 14000 and 26000 Standards, the TBL accounting framework, the Dow Jones Sustainability Index, EcoVadis, CSR Hub, academic papers, white papers, and business reports prepared by consultants such as McKinsey and KPMG. From this analysis, four groups of stakeholders emerged, with the UN's Sustainability Agenda serving as the linchpin linking the sustainability interests of the stakeholders. However, stakeholders in each category were found to have their own unique sustainability-related orientations.

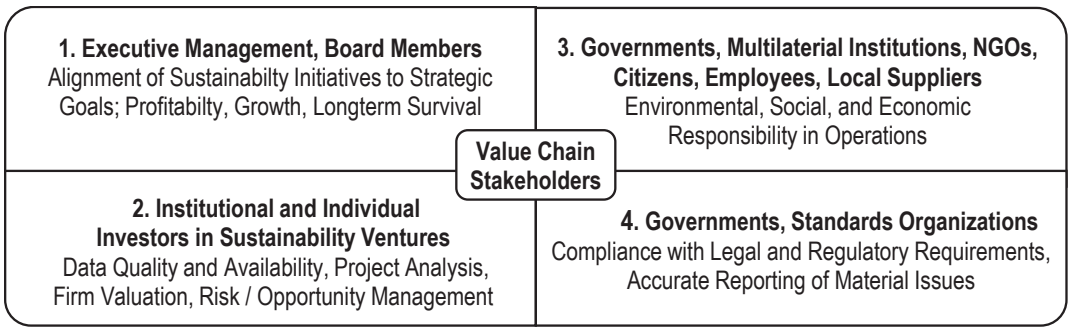

Figure 3: Categories of Stakeholders in Sustainable Global Value Chains

(i) **Executive management and board members** of the focal firm responsible for value chain results: Sustainability is no longer viewed as a philanthropic effort (Garza, 2013; PwC, 2014), but as a strategic opportunity to improve competitiveness and financial value (Ghemawat, 2010 as cited in Garza, 2013). Issues such as natural resource depletion, carbon footprint, climate-related hazards, and volatility in energy costs are being translated into strategic goals from which tactical and operational goals and activities are defined (Garza, 2013). Applied to sustainability, the current focus is on: (i) increasing revenue growth from improved reputation, brand image, innovative products that embed sustainability from concept to grave to appeal to existing and new customers, and (ii) maintaining or improving margins through operational efficiencies and cost avoidance of reputational and regulatory risk and future public costs (PwC, 2014).

(ii) **Investors** that finance and facilitate financing of sustainability ventures via loans and capital markets: The focus of individual and institutional investors is selection of sustainable projects that result in positive long-term portfolio results. While investors expect a return commensurate with the risk undertaken, they also recognize that the bigger goal is to meet the sustainable development goals (SDGs), as failure to do so will result in declining portfolio returns in the long run, e.g., due to higher disaster costs and higher insurance premiums. Projects are prioritized to reduce negative impacts and increase positive results. The requirements of this group can be summarized as follows: (i) sustainability projects that are linked to the strategic goals of companies committed to sustainability, (ii) sustainability projects that minimize risk and maximize opportunities, (iii) sustainability data that is credible, reliable, transparent, and of high quality, (iv) reporting of material issues in a manner that is commonly understood and easy to interpret (Anderson et al., 2016; UN Global Compact / PRI; Unruh et al., 2016).

(iii) **Governments, multilateral institutions, non-governmental organizations, community groups, employees, and citizens** who serve as watch dogs for the environment, economy, and society: According to Forbes (Straus, 2018) several indicators are used to determine the sustainability level of companies – from energy use, clean air production, and expenses on innovation, to suppliers selected, diversity of leadership, and how executive compensation is linked to sustainability targets. The 17 goals of the UN's Sustainability Agenda serve as the global guide on requirements to support social, economic, and environmental demands for this category.

(iv) **National governments and standards organizations** that create the legal and regulatory framework: The sustainability requirements of governments and standards bodies are derived from the broad goals of the sustainable development goals (SDGs) but provide specific guidance on the issues that must be reported and how they should be reported. The GRI (economic, social, environmental), ISO 14000 (environmental) and ISO 26000 (social) are examples of global guidelines that provide detail for sustainability compliance.

Step 2: Categorization and Coding of Stakeholder Sustainability Requirements

Based on the stakeholders identified, approximately 370 lines of data on sustainability requirements were collected. The data was initially classified by stakeholder type, and subsequently reviewed and coded into 12 themes that represent key learning areas (See Table 1).

Table 1: Summary of Learning Themes and Cognitive Levels Identified from Stakeholder Requirements

	Learning Themes	Bloom's Level
1	The global imperative for sustainable development	1 - 2
2	The case for corporate sustainability	2 - 4
3	Aligning sustainability strategy to corporate strategy	3 - 6
4	Value chain sustainability concepts	1 - 4
5	Assessing value-chain sustainability risks and opportunities	1 - 5
6	Sustainability and sustainability-related measuring systems and metrics	2
7	Trade-offs between supply chain / value chain goals and sustainability goals	4
8	Sustainability solutions for the value chain	3 - 6
9	Tools and skills for sustainable value chain design and management	3 - 6
10	Data management and analysis	3 - 4
11	Reporting on sustainability	3
12	Developing management and leadership skills to lead sustainability in the value chain	3 - 6

Each theme was further broken down into sub-topics to which a Bloom's Taxonomy level was assigned. Bloom's Taxonomy provides a framework of six cognitive levels that allows progressive development of competencies and critical thinking. The six levels – recall (1), understand (2), apply (3), analyze (4), evaluate (5), and create (6) – are further described in Figure 4 and Appendix A. Bloom's Taxonomy codes were assigned based on stakeholder requirements derived from the literature and the author's own experience in industry and academia (see Appendix B).

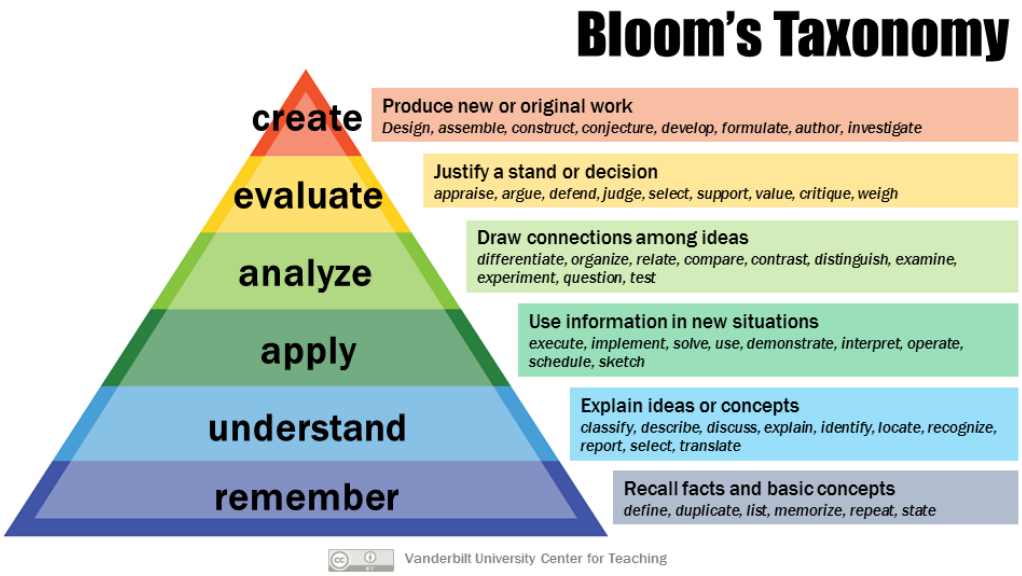

Figure 4: Hierarchies of Bloom's Taxonomy (Source: Vanderbilt University Center for Teaching)

Based on the thematic classifications that emerged from the analysis, a baseline was developed to provide a cumulative summary of Bloom's Taxonomy levels at which learning must be facilitated across the identified themes in Table 1, to prepare students to meet current sustainability challenges (See Figure 5).

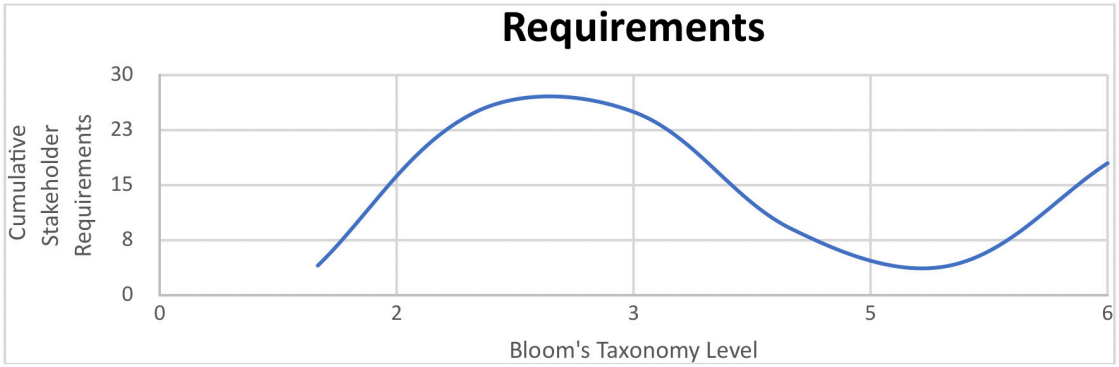

Figure 5: Cumulative Sum of Stakeholder-Required Learning Levels Across All Identified Topics at each Bloom's Taxonomy Level (Benchmark)

Step 3: Coding of Textbook Content

Students in industrial technology management programs often assume managerial positions in the value chain upon graduation. How well a student is prepared for future career roles depends, in large part, on the cognitive levels and skills developed through coursework and assignments. This implies that instructors need to present students with course learning materials and evaluations that stimulate cognitive processes at the right levels (Swart, 2010). While there is no rule on the amount of content that should be designated at each level, the majority of undergraduate work is evaluated at levels 1, 2, and 3, while the majority of graduate level work is tested at levels 4, 5, and 6 (Swart, 2010; Okbu.edu, 2018), with some crossover in both cases. Table 2 provides an example of value chain related coursework relevant to industrial technology management programs. Table 3 provides examples of the types of course topics and assignments on sustainability that can be integrated at various Bloom's Taxonomy levels in the value chain coursework of an undergraduate industrial distribution and logistics curriculum. The six courses represented are: Introduction to Distribution and Logistics (2000 level), Supply Chain Logistics (3000 level), Applied Engineering Economics (3000 level), Strategic Sourcing (4000 level), Strategic Pricing (4000 level), and International (Global) Logistics (4000 level).

Table 2: Examples of Value-Chain Related Coursework in an Industrial Distribution and Logistics Program

Courses that Address Primary Value-Chain Activities*	Courses that Support Primary Value-Chain Activities*
Supply Chain Logistics	Procurement
Manufacturing Processes	Strategic Sourcing
Warehousing	Project Management
Transportation	Applied Engineering Economics
Strategic Pricing	Product Design

*See Figure 1

A course taught at the 2000 level is considered to be an introductory course and is focused on providing a survey of the topics and supporting vocabulary that is necessary to lay a foundation for more advanced coursework. Content at the introductory level will typically focus on developing cognitive skills at Bloom's Taxonomy levels 1 and 2. Courses at the 3000 and 4000 levels are considered to be advanced undergraduate courses that progressively develop cognitive skills at Bloom's Taxonomy levels 2 and above. Examples of sustainability content for coursework at each of these levels is provided in Table 3.

To determine the depth and breadth of sustainability content currently available for value chain coursework, 23 popular textbooks relevant to coursework in industrial technology management programs were reviewed (See Appendix C). For this purpose, breadth refers to the range of sustainability topics that are relevant to industrial technology management programs and depth denotes the Bloom's Taxonomy level at which the material is covered. The subject index of each textbook was first consulted to locate key words relating to sustainability. Each reference was reviewed in further depth in the respective chapter. Following an examination of key words found in the subject index, a general review of each chapter was conducted to analyze additional content, including end of chapter assignments. The content was coded using Bloom's Taxonomy. The coded content was summarized to determine the frequency of each Bloom's Taxonomy level.

Step 4: Assessment of the Gap Between Stakeholder Requirements and Textbook Content

In this step, the Bloom's taxonomy level of textbook content was compared to that of the stakeholder requirements and summarized for three groups of textbooks: supply chain (supply chain, operations, transportation, logistics); procurement (purchasing, procurement, and strategic sourcing); and global logistics (international, global logistics). Procurement and global logistics courses, though part of the supply chain lexicon, were considered to be more specialized versions and therefore compared as individual groups.

Step 5: Provide Examples of How Sustainability Topics Can Be Integrated into Global Value Chain Coursework Using the Example of an Industrial Distribution Program

Following identification of deficiencies, the final step was to identify potential assignments that could be included in value chain coursework to augment textbook content and provide a more relevant learning experience for students. Examples of assignments are presented in Table 3.

Analysis

A comparison of coded textbook material to coded stakeholder requirements revealed the following:

(i) Sustainability is an emerging topic in value chain courses but textbook content lags behind the requirements of stakeholders in both depth and breadth. The majority of the content provided is at Bloom's Taxonomy Levels 1 and 2, even in textbooks that are not written at the introductory level.

(ii) Of the 23 books reviewed, 7 included a dedicated chapter or section on sustainability (typically the last chapter), while 7 integrated sustainability concepts within the various chapters of the book. The other textbooks addressed the subject very briefly or not at all.

(iii) There is inadequate material to support critical thinking, problem solving, systems thinking, and innovation at Bloom's Taxonomy Levels 3 and above (e.g. apply, analyze, evaluate, create). The development of skills and competencies, e.g., evaluation of trade-offs between sustainable development goals (SDGs) and supply chain objectives, network design, total cost analysis, supplier evaluation, pricing, and application areas that emphasize collaboration, interlinkages, and understanding of interdependencies are some examples where supplementary content needs to be developed. For example, one textbook that could be used for an applied engineering economics class began many chapters with a sustainability issue but did not provide solution examples to support a teaching and learning dialogue.

(iv) The majority of the books failed to link the sustainability challenge to the UN's SDGs; yet, the sustainability challenge is a global one. There is also virtually no mention of the Global Reporting Initiative (GRI) or the G4 standards used globally by many companies for sustainability reporting.

(v) Beyond value chain competencies, there is a need to support learning in the areas of data management, reporting, systems thinking, transformational leadership and change management (See Figures 6, 7, and 8).

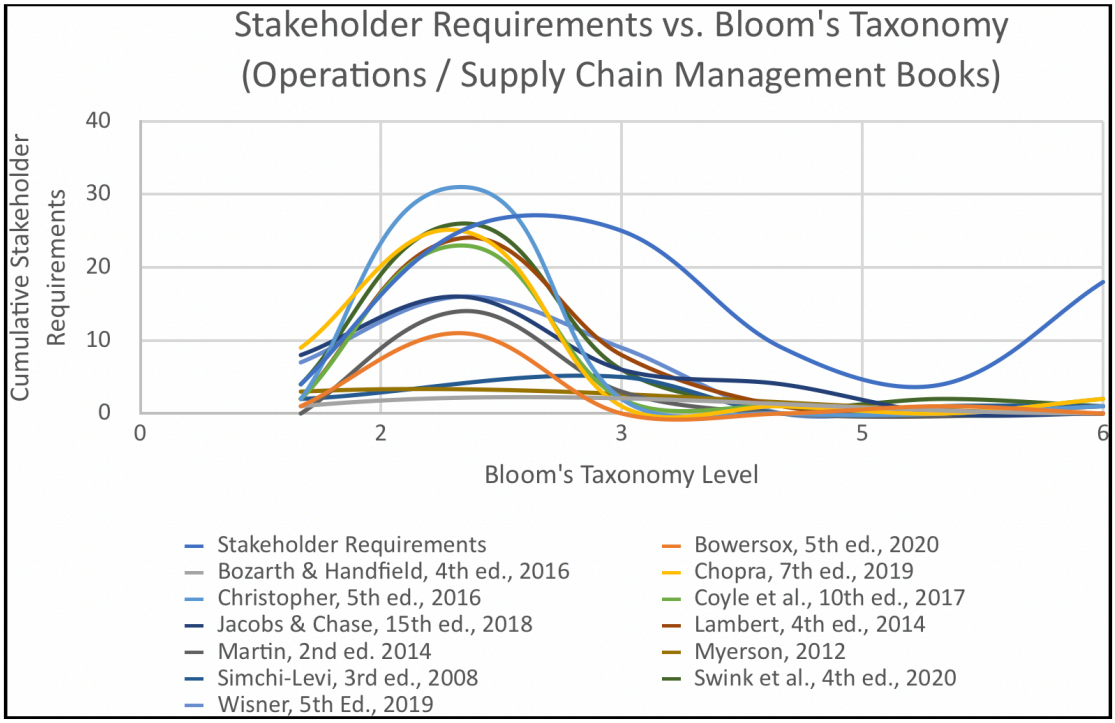

Figure 6: Summary of Stakeholder Requirements vs Bloom's Taxonomy Levels for Operations, Logistics, Supply Chain Books

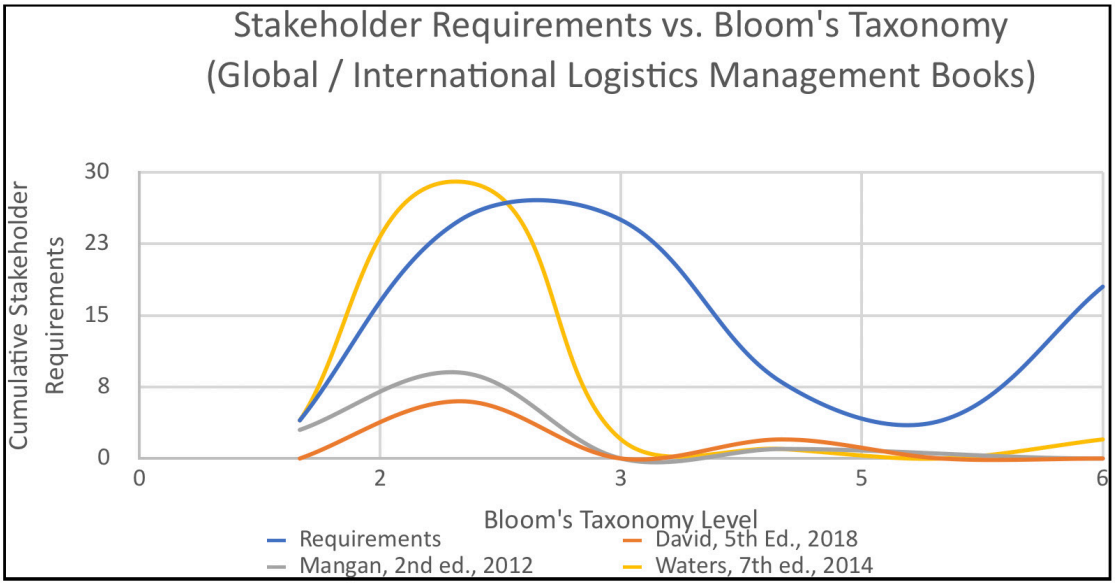

Figure 7: Summary of Stakeholder Requirements vs. Bloom's Taxonomy Levels for Purchasing and Sourcing Books

Figure 8: Summary of Stakeholder Requirements vs. Bloom's Taxonomy Levels for Global Logistics, International Logistics Books

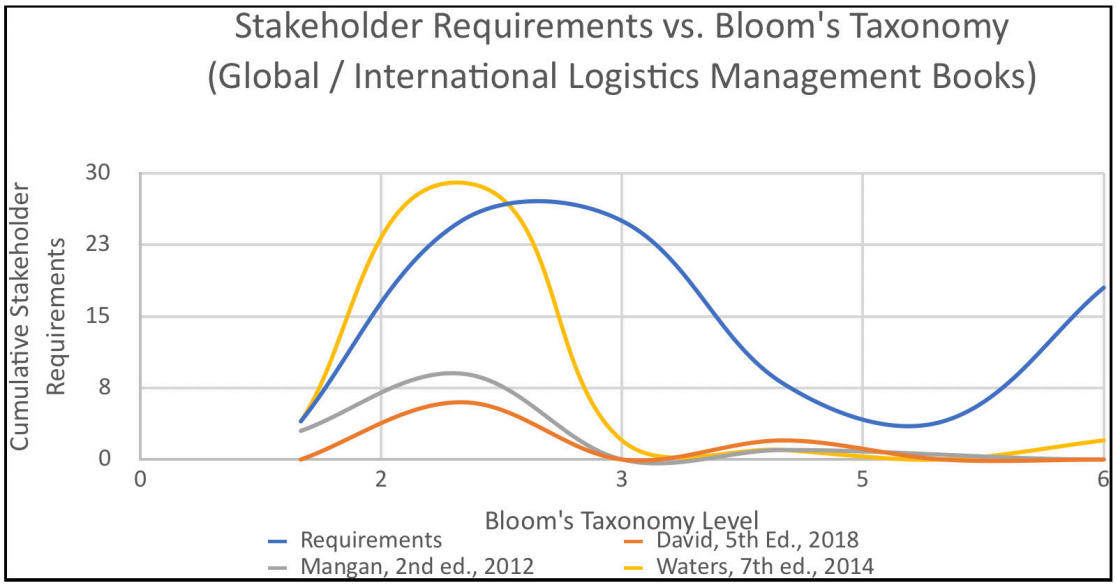

Table 3: Examples of Content for Various Courses in an Industrial Distribution and Logistics Program

Course Level / Name	Examples of Content	Suggested Assignments for Further Development
Course #: 2000 Introduction to Distribution & Logistics	**Blooms Level 1 – 2** (Suggest use of book with dedicated chapter on sustainability). Definition of sustainability Origin of sustainability Sustainability challenges Impact of global trade on sustainability issues International agreements and conventions relating to sustainability Global Reporting Initiative (GRI) The UN Sustainable Development Goals Sustainability indexes, metrics	**Bloom's Taxonomy – Level 1** Vocabulary (define, describe, match) E.g. Sustainability, GRI, UN Global Compact, ISO 14000, ISO 26000, greenhouse gas emissions, carbon footprint, life cycle assessment, concept to grave, cradle to grave, renewable / non-renewable resources, eco-efficiency, Triple Bottom Line, Dow Jones Sustainability Index, Paris Agreement, Cap and Trade Legislation sustainability audit. **Bloom's Taxonomy – Level 2** Give examples of UN SDGs, sustainability indexes, metrics. Explain the link between the rise in global trade and increase in sustainability challenges.
Course #: 3000 Supply Chain Logistics	**Bloom's Level 1 – 3** (Suggest use of book with sustainability integrated into chapters). Introduction to systems thinking Trade-offs between sustainability and traditional supply chain goals Link between activities in the value chain Mapping of sustainable value chain Identification of sustainability risks and opportunities along the value chain Strategic, tactical, and operational sustainability initiatives	**Bloom's Taxonomy – Level 2** Discuss an example of a conflicting objective between a sustainability goal and a traditional supply chain goal. What trade-offs can be made to best achieve both goals? Explain why the value chain provides a better perspective for viewing sustainability challenges and solutions than the supply chain. **Bloom's Taxonomy – Level 3** Map out the supply chain for an item from point of origin to point of use and identify the main sustainability risks, including natural disaster risks. Estimate the likelihood and impact for each risk and calculate an FMEA score for the supply chain.

Course Level / Name	Examples of Content	Suggested Assignments for Further Development
Course #: 3000 Applied Engineering Economics	**Bloom's Taxonomy 1 – 3** (Suggest use of book with sustainability integrated into chapters). Vocabulary (define, describe, match) Examples of terms (with respect to sustainability): one-time cost, opportunity cost, life cycle cost analysis, NPV, ROI, Benefit / Cost Costs relevant to sustainability projects, e.g., disposal costs, transportation of landfill waste, cost of emissions involved in waste disposal, cost of grinding and repalletizing recycled plastics. Benefits relevant to sustainability projects, e.g., energy reduction, water conservation, carbon footprint reduction, cost reduction, efficiency Non-traditional methods to calculate enhanced NPV (e.g. NPV+) to evaluate sustainability projects	**Bloom's Taxonomy – Level 1** Identify the applicable costs and benefits to evaluate a renewable energy (e.g. solar) project in a warehouse. **Bloom's Taxonomy – Level 2** Why are traditional time value of money techniques not appropriate for evaluating sustainability projects? Explain the rationale behind using the NPV+ approach to evaluate sustainability projects. **Bloom's Taxonomy – Level 3** Using a spreadsheet, calculate the NPV of the life cycle costs and benefits for a sustainable fleet of delivery trucks. Calculate the Benefit/Cost ratio for the following two options for handling end of life packaging: recycling vs. waste disposal.

Course Level / Name	Examples of Content	Suggested Assignments for Further Development
Course #: 4000 Strategic Pricing	**Bloom's Taxonomy 2 – 5** (Suggest developing additional material that integrates sustainability into topics). Market segmentation to identify sustainability-conscious customers Value-based pricing of eco-products Behavioral based pricing toward eco-friendly products Pricing of sustainability products to align with competitive positioning Pricing of innovative eco products Bundling of eco-products Application of two-tier tariffs, peak pricing to resource usage	**Bloom's Taxonomy – Level 2** Explain why segmentation is a necessary first step in pricing sustainable products. Explain how you would collaborate with an NGO to set a price for a sustainable product. **Bloom's Taxonomy – Level 3** Apply the economic value approach to calculate the maximum price at which a new biodegradable packaging material can be sold. **Bloom's Taxonomy – Level 5** Recommend a pricing strategy that could be applied to realign buying behavior towards a specific eco-product. Justify your choice.

Course Level / Name	Examples of Content	Suggested Assignments for Further Development
Course #: 4000 Procurement / Sourcing	**Bloom's Taxonomy 3 – 6** (Suggest use of book that integrates sustainability into chapter topics). Spend analysis, e.g., renewable, non-renewable resources Sustainability audit of suppliers for environmental, social, economic criteria Supplier evaluation and selection Total cost of ownership Life cycle analysis Collaboration with suppliers to develop eco-products, manage natural resources, reduce waste, implement social sustainability programs Child labor Human trafficking Supplier compliance at all tiers of supply chain, e.g., Dodd-Frank Reporting on results of supplier audit	**Bloom's Taxonomy – Level 2** Explain how emerging technologies such as blockchain are being used to ensure more sustainable supply chains. Give some examples. **Bloom's Taxonomy – Level 3** Calculate a supplier score that includes sustainability criteria using the weighted average method. Compute local supplier expenditure as a percentage of total purchase expenditure. **Bloom's Taxonomy – Level 5** Evaluate the Total Cost of Ownership for a product sourced from two different suppliers in two different countries. In each case, include the cost of carbon emissions in the analysis. With respect to the three dimensions of sustainability, evaluate (i) the immediate impact and (ii) long term impact of human trafficking in the supply chain of a purchased item. In each case, discuss the impacts on each of the three dimensions of sustainability. **Bloom's Taxonomy – Level 6** Create a supplier scorecard that includes sustainability metrics, e.g., water usage, renewable energy usage, local community impact. Design a checklist to audit a supplier's sustainability level with respect to the economic, social and environmental SDGs. What factors would you include?

Course Level / Name	Examples of Content	Suggested Assignments for Further Development
Course #: 4000 Global Logistics	**Bloom's Taxonomy 3 – 6** (Suggest integrating sustainability into topics). Impact of distance and mode of transportation on GHG Logistics network design Total landed cost calculations Sustainability trade-offs in global supply chain (e.g. lean, agile supply chains)	**Bloom's Taxonomy – Level 4** Compare and contrast sustainability risks in the logistics infrastructure of two different countries. **Bloom's Taxonomy – Level 6** Using an applied simulation software package, design a supply chain network to minimize total GHG across the entire supply chain. Explain the trade-offs that you would make to improve sustainability of the overall supply chain.

Conclusion

Managing value chain operations to support the sustainable development goals (SDGs) is no longer a philanthropic choice but a corporate priority. To align with this new agenda, the sustainability skills of industrial technology management students must be developed to underpin potential future roles in the global value chain. Because the sustainability content of textbooks falls short in terms of both depth and breadth of the sustainability requirements identified for value chain stakeholders, supplementary course learning materials and assignments, particularly at Bloom's Taxonomy Levels 3, 4, 5 and 6, are required. This need opens up the opportunity to conduct future research on developing sustainability teaching materials and testing content effectiveness in meeting talent requirements.

This paper analyzed textbook content against a benchmark developed for stakeholder requirements from literature in the public domain and the author's experience in diverse positions. The framework can be further developed and validated by soliciting information on requirements directly from stakeholders.

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Appendix A: Bloom's Taxonomy

Bloom's Level	Bloom's Taxonomy	Class	Learning Level	Level of Thinking
1	Recall	Undergrad	Recognize and recall facts, concepts, theories, definitions, formulas, dates, events. State, name, describe, list, label, find. Questions: What is? Can you list? Can you arrange? Can you choose? Can you describe? When? Which one? Can you match?	Lower order convergent
2	Understand	Undergrad	Understand what the facts mean; explain, classify, describe, discuss, identify, locate, recognize, differentiate, report, select, interpret, predict, give an example. Questions: How would you summarize? Can you explain? What is meant by?	Higher order convergent
3	Apply	Undergrad	Apply the facts, rules, concepts; Use information in new situations – execute, implement, solve, illustrate, demonstrate, interpret, operate, schedule, sketch, map. Questions: How would you solve? Can you give some examples of? What approach?	Higher order convergent
4	Analyze	Graduate / Advanced Undergrad	Breakdown information into component parts; Draw connections among ideas / concepts taught in other courses. Differentiate, organize, relate, compare, contrast, distinguish, examine, supply a reason, cause Questions: Can you differentiate between? What is the relationship between?	Lower order divergent (critical thinking)
5	Evaluate	Graduate	Judge the value of information or ideas; Justify a stand or position. Appraise, defend, judge, select, support, value, critique, weigh; Questions: What would you recommend? How would you prioritize?	Higher order divergent (critical thinking)
6	Create	Graduate	Combine parts to make a new whole; Produce new or original work. Design, assemble, construct, develop, author, investigate; respond creatively and originally to problems and scenarios Questions: How would you improve? What changes would you make?	Higher order divergent (critical thinking)

Convergent thinking: assembling or combining elements of a topic together
Divergent thinking: disintegrating a topic into its constituent parts
Compiled from the following sources: Armstrong, P., Center for Teaching, Vanderbilt University; American Public University; Stanny, C.J. (2016); University of Arkansas; Leroy, R.V.H. (2011).

Appendix B: Stakeholder Requirements Translated into Competencies

Stakeholder Needs Analysis	Bloom's Taxonomy
1. <u>The global imperative for sustainable development</u>	
a) Origin of sustainable development - World Commission on Environment and Development (WCED), Brundtland Report	1
b) Definition of sustainability (WCED, 1987)	1
c) International institutions, agreements, and conventions driving the sustainability imperative e.g. UN Global Compact, Global Reporting Initiative (GRI), Paris Climate Agreement, International Kyoto Agreement, Anti-bribery Convention, etc.	2
d) Sustainability-related challenges	2
e) The 17 Sustainable Development Goals (SDGs): description, purpose, challenges	2
f) Market versus social costs, e.g., carbon footprint, biodiversity	2
g) Value chain as a critical conduit for achieving the SDGs	2
2. <u>Business case for corporate sustainability</u>	
a) The move from philanthropy to strategic imperative	2
b) Link between globalization, trade, and social, economic and environmental problems	2
c) Role of corporations in achieving the SDGs	2
d) Factors driving sustainability adoption, e.g., long-term survival of the firm, future shortage of resources, product quality, traceability requirements, operational efficiency (e.g. green cost savings, waste reduction, cost avoidance by preventing legal and regulatory violations), customer demands for ethically-produced goods and ethical practices in the value chain, strategic supplier relationships, culture of responsibility to support common good, legislation	2
e) Sustainability as a competitive advantage, e.g., (i) improved reputation, increased compliance, mitigation of unfavorable press coverage, (ii) market growth through customer retention, increased brand integrity, new customers and markets resulting from expanded offerings of innovative, overseas markets, ethical products; (iii) superior financial performance, e.g., return on investment, return on equity / assets, earnings per share	4
f) Link between corporate strategy and sustainable development goals (SDGs)	2
g) Importance of commitment to sustainability	
3. <u>Aligning sustainability strategy to corporate strategy</u>	
a) Crafting a sustainability vision, mission, values	6
b) Setting sustainability goals and objectives that align with sustainability vision and support corporate strategy	4
c) Developing a code of conduct based on international standards, e.g., UN Declaration of Human Rights, International Labor Organization (ILO) etc.	3
d) Communication of a consistent message across the organization and its value chain	3
e) Developing stakeholder partnerships and alliances to solve challenge of SDGs, e.g., cooperative ventures with government, stakeholder alliances	3

Stakeholder Needs Analysis	Bloom's Taxonomy
4. Value chain sustainability concepts	
a) Definition of supply chain, value chain, supply chain (value chain) sustainability	1
b) Michael Porter's Value Chain - primary and supporting activities	2
c) The link between activities in the value chain	4
d) Product design from concept to grave	4
e) Objectives of value chain (supply chain) sustainability	2
f) Reasons for driving sustainability from the value chain perspective	2
g) Steps in supply chain sustainability: commit, evaluate, define, implement, measure, communicate, appropriate for size and situation of company	3
h) UN and other initiatives and resources to support value chain sustainability, e.g., UN Global Compact, Child Labor Platform, Caring for Climate (C4C), Business for the Rule of Law (B4ROL), Dodd-Frank (conflict minerals)	2
i) Integrated vs. functional approach to sustainability across the value chain	4
5. Assessing value-chain sustainability risks and opportunities	
a) Value chain sustainability risks and opportunities	1
b) Steps in identifying value chain sustainability risks and opportunities	2
c) Supply chain primary activities (e.g. inbound logistics, operations, outbound logistics) as a major source of environmental, social, and economic challenges	5
d) Risks and opportunities in the primary activities of the value chain, e.g., Greenhouse Gas Emissions (GHG), waste, water pollution, community involvement, support of local entrepreneurs	5
e) Risks and opportunities in the supporting activities of the value chain, e.g., procurement, design of products, preferred suppliers, pricing	5
f) Prioritizing value chain sustainability risks and opportunities	5
6. Sustainability and sustainability-related measuring systems and metrics	
a) Triple Bottom Line (TBL) Accounting Framework (people, planet, profit)	2
b) Difference between economic measures of TBL and economic measures of SDGs	2
c) Global Reporting Initiative (GRI)	2
d) Metrics used for GRI reporting (environmental, social, economic) e.g., fuel consumption, percent of recycled material used in a product, number of jobs supported in the supply or distribution chain, percent of procurement budget spent on local suppliers, GHG in metric tons of CO_2 equivalent	2
e) Metrics used by companies to measure sustainability e.g., number of green products, training hours per employee, weight of hazardous waste	2
f) Financial metrics used by investors, ROI, Earnings per Share (EPS), NPV	2
g) Supply chain metrics e.g. cycle time, days in transit, delivery performance	2
h) Logistics-related metrics e.g. transport intensity, food miles	2
i) Sustainability ratings, rankings and indices e.g. Dow Jones Sustainability World Index, FTSE4good index, EcoVadis, Sustainalytics	2
7. Trade-offs between supply chain / value chain goals and sustainability goals	
a) Sustainability value as the sum of trade-offs, e.g., lean vs. large orders; days in transit vs. mode of transportation; customization vs. postponement; small batch size vs. inventory carrying cost; focused factories vs. local factories; centralized distribution vs. decentralized warehouses; global sourcing vs. local sourcing; inventory storage vs. cross-docking; traditional vs. closed loop supply chain; agility vs. efficiency	4

Stakeholder Needs Analysis	Bloom's Taxonomy
8. Sustainable solutions for the value chain	
a) Environmental legislation, e.g., Emission Trading Schemes (Cap and Trade)	3
b) Design: design of product for sustainability - reuse/recycle; choice of raw materials and packaging (biodegradable, lightweight, less bulk); physical properties of product	6
c) Source: location of suppliers, impact on environment, natural resource management; ethical and societal issues, e.g. workers' rights, child labor, gender	6
d) Produce and warehouse: e.g., energy efficiency; renewable vs. non-renewable energy, waste reduction, lean solutions, pollution reduction; traceability	6
e) Distribute: network optimization; mode of transport; asset utilization; transport sharing; vehicle routing; technology; hybrid fuels etc.	6
f) Return: disposal, reverse logistics, closed loop supply chains	6
g) Economic sustainability solutions, e.g., community investments, fair trade products, ethical pricing	6
h) Green marketing strategies	6
i) Code of conduct	6
9. Tools and skills for sustainable value chain design and management	
a) Collaborative product and packaging design for sustainability; eco-product design	6
b) Process design for sustainability; eco-efficiency	6
c) Traditional and enhanced project evaluation methodologies, e.g., DCF, NPV plus	3
d) Project management – goal setting, scope, budgeting, scheduling, etc.	3
e) Life Cycle Analysis (cradle to grave; cradle to cradle)	3
f) Total Cost of Ownership (TCO) – including sustainability costs e.g. carbon footprint	3
g) Pricing strategies for sustainable products, services	3
h) Risk management, e.g., detection, probability, impact, mitigation	3
i) Resources on traceability, e.g., online guides such as GreenerChoices.org	3
j) Application of technologies, e.g., blockchain, RFID, Intelligent transport	6
k) Value / supply chain modeling, simulation	6
l) Design of closed loop supply chains	6
m) Logistics network design	6
n) Lean methodologies	3
o) Auditing of sustainable value chains	3
p) Continuous improvement	3
q) Supply chain mapping	3
r) Supplier evaluation methodologies	3
10. Data management requirements	
a) Capture, storage, retrieval, use, data analysis	3
b) Credibility, accuracy, quality, integrity	3
c) Confidentiality	3

Stakeholder Needs Analysis	Bloom's Taxonomy
11. Reporting on sustainability	
a) Commonly used international standards, e.g., GRI, ISO 14000, ISO 26000	3
b) National and internal standards (including financial standards ERDB, SEC, Dodd-Frank	3
c) Legal requirements, e.g., Directive 2014/95/EU	3
d) Presentation; supporting statements with facts, evidence	3
12. Developing management and leadership skills for sustainable value chain management	
a) Systems thinking for sustainable value chain management.	4
b) Communicating and enforcing corporate code of conduct for sustainability	6
c) Interpersonal communication strategies for sustainable value chain management	4
d) Public presentations	6
e) Managing change and transformation, e.g., training, coaching, goal-setting, listening, information sharing, dealing with conflict, negotiation, motivation, collaborative problem solving, inclusion, diversity, appraisal, feedback, facilitating innovation, teamwork	3
f) Incentive programs	6

Sources:

UN Global Compact website, UN report on Investor Needs in Business Reporting on Sustainable Development Goals (SDGs), Supply Chain Sustainability – A Practical Guide for Continuous Improvement, 2nd ed., GRI 2016 Sustainability Reporting Standards, ISO 14000, ISO 26000, Triple Bottom Line Accounting framework, Dow Jones Sustainability Index, EcoVadis, CSR Hub, McKinsey, KPMG Corporate Responsibility Survey, 2017, Dubey & Gunasekaran, 2015, Gosling et al., 2017, Seuring & Muller, 2008, Thorklakson et al., 2018, Unruh et al., 2016.

Appendix C: Textbooks Reviewed for Sustainability Content

Author(s)	Book Title	Comments*
Benton, W.C.	Purchasing and Supply Chain Management, 3rd ed., 2014, McGraw Hill	1
Bowersox et al.	Supply Chain and Logistics Management, 5th ed., 2020, McGraw Hill	2
Bozarth & Handfield	Introduction to Operations and Supply Chain Management, 4th ed., 2016, Pearson	1
Chopra	Supply Chain Management: Strategy, Planning and Operation, 7th ed., 2019, Pearson	3
Christopher, M.	Logistics and Supply Chain Management, 5th ed., 2016, Pearson	3
Coyle et al.	Transportation: A Global Supply Chain Perspective, 8th ed., 2016, Cengage Learning	1
Coyle et al.	Supply Chain Management – A Logistics Perspective, 10th ed., 2017, Cengage Learning	1
David, P.	International Logistics: The Management of International Trade Operations, 5th ed., 2018, Cicero Books	1
Jacobs & Chase	Operations and Supply Chain Management, 15th ed., 2018, McGraw Hill Education	2
Johnson & Flynn	Purchasing and Supply Management, 15th ed., 2015, McGraw Hill Education	2
Lambert	Supply Chain Management: Processes, Partnerships, Performance, 4th ed., 2014, Supply Chain Management Institute	2
Mangan et al.	Global Logistics and Supply Chain Management, 2nd ed., 2012, John Wiley & Sons	3
Martin	Lean Six Sigma for Supply Chain Management, 2nd ed., 2014, McGraw Hill Education	3
Monckza et al.	Purchasing and Supply Chain Management, 6th ed., 2016, Cengage	2
Myerson	Lean Supply Chain and Logistics Management, 2012, McGraw Hill Irwin	0
Nagle et al.	The Strategy and Tactics of Pricing, A Guide for Growing More Profitably, 6th ed., 2018, Taylor and Francis	0
Newnan et al.	Engineering Economic Analysis, 13th ed., 2017, Oxford University Press	2
Simchi-Levi et al.	Designing and Managing the Supply Chain: Concepts, Strategies and Case Studies, 3rd ed., 2008, McGraw Hill Irwin	0
Smith	Pricing Strategy, 2012, Cengage Learning	1
Sollish & Semanik	Strategic Global Sourcing, Best Practices, 2011, John Wiley & Sons	3
Swink et al.	Managing Operations Across the Supply Chain, 4th ed., 2020, McGraw Hill Education	3
Waters. D.	Global Logistics, New Directions in Supply Chain Management, 7th ed., 2014, Kogan Page Limited	3
Wisner et al.	Principles of Supply Chain Management, A Balanced Approach, 5th ed., 2019, Cengage	2

*3 = Dedicated chapter/section on sustainability; 2 = Sustainability concepts and / or examples integrated into one or more chapters; 1 = Brief mention/reference of sustainability, 0 = No mention of sustainability