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Understanding the Implications of Chemical Regulations, Circular Economy and Corporate Social Responsibility for Product Stewardship

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Abstract. Chemical regulations exist to limit and control the amount of hazardous chemical substances being used by industry to mitigate potential risks. Increasing awareness of diminishing natural resources, increasing pollution, and reducing the amounts of harmful waste, has led towards pressure on industry to change from the traditional linear economic model (closed-loop manufacturing), towards the adoption of the Circular Economy (CE) activities. Corporate Social Responsibility (CSR) extends the relationship between industry and society, defining strategy and communications. The speed at which chemical regulations, CE and CSR adoption takes place will depend on: (1) the speed at which natural resources become more depleted; (2) increasing awareness of the effects of chemical substances by regulators and consumers; (3) increasing numbers of chemical substances being regulated as hazardous, and; (4) increasing consumer and societal pressures for change. Product Stewardship (PS) can be viewed as: (1) involving a wide range of functional areas (design, manufacture, purchasing, sales, support); (2) identifying health and safety, and environmental impacts of product(s); (3) ensuring adequate measures are in place to understand, control or limit impact(s) against a product throughout its lifecycle. The aim of this paper is to focus on using a literature review. The conclusions from this paper will attempt to outline a framework for PS to align with CE and CSR.

Keywords: chemical regulations; product stewardship; circular economy; corporate social responsibility; environmental management; leadership; sustainability.

1. Introduction

Supply chains can be defined as a collection of actors working together to enable: (1) availability of raw materials (2) conversion of raw materials into chemical substances, chemical mixtures, materials, semi-components, components, into finished products; (3) distribution of finished products to consumers (Beamon, 1998; Takhar and Liyange, 2018). Chemical substances are the lowest level ingredient which are can be used on

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their own or combined with other chemical substances to produce mixtures or materials. There are over 146 million chemical substances defined in the main chemical database system (CAS, 2019). Chemical regulations exist to control and limit the use of hazardous substances within society. The traditional linear economy works based on using raw materials to produce finished products which are then consumed and then disposed of. Increasing awareness of the environmental impacts of using the linear economic model, resulting in diminishing natural resources led towards CE model of open-loop manufacturing systems, where products now undergo cycles of repair, reuse, and recycling of materials (EC, 2015; Zeng, et al., 2017). Identification of chemical substances contained within products is a crucial enabler to the CE. CSR extends the role of a business in terms of its wider impacts on society and the environment. The traditional pillars of Product Stewardship (PS) focus on examining product lifecycles in terms of health, safety and environmental impacts.

1.1. Research objectives

This paper contributes to the field of chemical regulations, CE, CSR and PS literature by addressing the following research objectives: (1) identify key concepts, developments and issues relating to the impacts of chemical regulations, CE, CSR and PS; (2) develop an initial action plan to embed chemical regulations, CE and CSR into PS.

1.2. Paper structure

This paper is organized as follows: (1) in section 2 the research methodology is discussed; (2) in section 3 the literature review is presented; (3) in section 4 conclusions to this research paper are presented.

2. Research Methodology

The search terms used were: ‘chemical regulations’, ‘product stewardship’, ‘circular economy’ and ‘corporate social responsibility’ appearing within the title of an article. selecting the most relevant articles. The search engines used: (1) Google Scholar (scholar.google.co.uk); (2) Scopus (scopus.com); (3) ScienceDirect (sciencedirect.com), and; (4) PubMed (ncbi.nlm.nih.gov/pubmed).

3. Literature Review

3.1. Chemical regulations

Regulations exist to present society with a set of rules to maintain a consistent set of norms. Chemical regulations aim to control and limit the use of hazardous chemicals, by establishing a regulatory framework to: (1) manage the manufacture; (2) use; (3) labelling and disposal of chemical substances. Chemical regulations define: (1) standards manufacturers need to comply with; (2) monitoring of chemical substances; (3) controlling and / or restrict the use of more hazardous substances; (4) the activities of regulatory bodies to enforce the industry control measures (Botos, Graham, Illés, 2018).

Chemical regulations implement data reporting requirements which aid data collection from industry to identify gaps related to: (1) known uses of a substance, or; (2) whether a substance is safe or not; (3) identification of risk assessment measures; (4) research and development; (5) enabling the use of safer alternative substances (Koch and Ashford, 2006; Wilson and Schwarzman, 2009; Tickner, et al, 2015; Krimsky, 2017; Botos, Graham, Illés, 2018; Negev, et al, 2018; Sackmann, et al, 2018). The negative impacts of chemical regulations include: (1) regrettable substitution where regulated substances are substituted with substances that show same chemical profiles as the regulated substances (Geiser, et al, 2015; Tickner, et al, 2015; Tickner and Jacobs, 2016; Sackmann, et al, 2018); (2) they can be seen as potential trade barriers; (3) concerns have been raised over the ability of small and small medium sized enterprises to accurately collate and interpret the required reporting information needed (Olsen, et al., 2010; Legg, et al., 2015); (4) the costs of adhering to the requirements of chemical regulations may be underestimated. Manufacturers and producers need to understand the impacts of chemical regulations, as they can result in subtly different reporting needs and required actions. To meet the needs of chemical regulations industry has had to develop new systems to record data relating to chemical substances used internally and across the supply chain for procured products (Takhar and Liyange, 2018).

3.2. Sustainability, Extended Producer Responsibility (EPR) and CE

The traditional linear economic model focuses on raw materials being consumed with other raw materials to produce products. These products are then used by end consumers, who dispose of them with little recycling taking place. This results in a scenario where natural resources become scarcer because of on-going demand for products. The Brundtland report (WCED, 1987) focused on stating current needs of society could be achieved without diminishing resources and capabilities for future generations. Four keys areas from the report: (1) sustainable development; (2) environment protection; (3) economic growth and (4) social equity. The key areas from the Brundtland report have formed the basis for sustainability frameworks (economic, social, environmental). The aims of sustainability include: (1) designing products which do not rely on scarce natural resources; (2) producing products which last longer and do not require replacement or repair; (3) products are made using materials which can be recycled easily (WCED, 1987; Carter and Rodgers, 2008; Tate, Ellram, Dooley, 2012; Kanchanapibul, 2014; EC, 2015; Kolotzek, et al., 2018). Established in 2015, the UN Sustainable Development Goals (SDG's) set out 17 high level goals, with 169 lower levels to achieve sustainable social and economic development by 2030 (UN SDG, 2019). UN SDG 12 *'Responsible Consumption and Production'* describes the need for sustainability by a producer to implement a 10-year framework covering sustainable consumption and production (UN Goal 12, 2018). Sustainability frameworks provide the basis for analyzing the impacts and benefits when considering different products. (Krajnc, Glavic, 2005; Ahmadi, Kusi-Sarpong, Rezaei, 2017; Dizdaroglu, 2017). Sustainability results in more highly durable products, which require less repair, servicing ultimately eliminating the need for replacement products (Tate, Ellram, Dooley, 2012; Kolotzek, et al., 2018). EPR has placed additional obligations on producers to act in a responsible manner in both product design and the collection and recovery of materials from End of Life (EOL) products (OECD, 2001; Thun and Müller, 2010; Wagner, 2013; EC, 2014; EC, 2015). Sustainability and EPR result in: (1) designing products which last longer in use; (2) reduction in hazardous substances being sent to landfill; (3) produce products which can

be recycled, creating secondary raw materials (OECD, 2001; Thun and Müller, 2010; EC, 2014; OECD, 2016). CE can be seen as an extension of sustainability enabling a movement towards open-loop manufacturing, where increasing use of the evolution of the R-imperatives: (1) reduce the amounts of consumer demand and use of scarce materials by a manufacturer, (2) resell / reuse of products, which are used by one consumer then sold and reused by another consumer; (3) repair small ad-hoc changes applied to products for continued use; (4) refurbish products where products are overhauled, (5) remanufacture products where new parts may be added to a product; (6) repurpose products for new uses; (7) recycle materials from a product to extract secondary raw materials. (EC, 2015; Zeng, et al., 2017; Reike, et al., 2018; Ellen MacArthur Foundation, 2019). The UN SDGs provide the targets to enable more sustainable behaviours, however moving towards CE requires a long-term shift in societal behavior, requiring industry, governments and society accepting the need to make the required changes.

3.3. CSR

CSR arose from the belief that industry should act more in responsible ways towards society and the environment, not purely to generate economic gain for its stakeholders. CSR research dates to the 1950's, when the concept of a socially responsible business was first discussed in research circles. In 1970, Milton Friedman coined the phrase *"social responsibility of business"* (Friedman, 1970), primarily focusing on bringing about social improvements via charitable donations, which could potentially result in financial impacts to an organization. CSR evolved rapidly during from the late 1990s onwards due to: (1) climate change and global warming issues; (2) media coverage highlighting organizations acting irresponsibly, for example negative natural resource consumption, waste pollution, worker conditions; (3) increasing consumer pressure for changes from industry. Initially industry reacted slowly towards the need for change, by using CSR to as a means of public relations and media campaigns. A dominant claim of CSR was a duty to be a good citizen and act in an ethical manner, improving any prevailing social concerns. CSR has become a multidisciplinary methodology which can be applied across all functional areas of a business to bring about a change in corporate culture, to enable organizations to act in a more responsible manner (Carroll, 1999; Porter and Kumar, 2002; Porter and Kumar 2006; Kirat, 2015; Lim and Greenwood, 2017; Zhou and Eyun-Jung, 2018; Zhang, et al. 2018; Zhou and Eyun-Jung, 2018; Kudłaka, et al., 2018). The benefits of using CSR include organizations becoming more socially responsible enables companies to: (1) increase brand reputation; (2) attract higher quality talent pools; (3) increasing profits and share values (Tate, Ellram, Dooley, 2012; Kirat, 2015; Lim and Greenwood, 2017; Zhou and Eyun-Jung, 2018; Zhang, et al. 2018; Kudłaka, et al., 2018; West, et al, 2018;). CSR impacts PS, in that it makes an organization observe current internal and external practices, aligning them in a more socially responsible manner.

3.4. Product stewardship (PS)

PS is defined as examining the health, safety, environmental and social impacts of a product across its life span. PS requires everyone involved in the life span of a product taking actions to reduce any negative impacts (Bennett, el al, 2018). These actions encompass: (1) assessment of materials used within a product; (2) producing products

which minimize the use of hazardous chemicals; (3) utilizing EPR schemes to collect products at the EOL stage; (4) recycle materials and safely dispose where required; are collected using EPR schemes; (5) The resultant behaviour expected being products being manufactured which are made from more environmentally friendlier materials (Wiki, 2018; PSI, 2019). Chemical Regulations, EPR, CE and CSR can play a pivotal role in directing PS strategies.

4. Conclusions

4.1. Summary

Industry exists to generate economic gain for its stakeholders, through the sale of goods and / or services. PS strategies need to align to: (1) the obligations of chemical regulations, and; (2) the movement away from the linear economic model towards the CE and CSR type models.

Table [1] shows the initial conceptual framework as applicable to the original product manufacturer, and its relevant internal stakeholders. The initial framework shall allow for PS strategies to be applied to: (1) initial transformation cycle for new products (conversion of raw materials into finished products); (2) repair of used products by the original manufacturer; (3) collection of used EOL products on behalf of the original manufacturer; (4) reprocessing activities by original manufacturer in terms of refurbishment and recycling, note - repurposing is assumed to be undertaken by external to system actors and not in scope of the original manufacturer activities.

The original manufacturer shall by adopting such a framework be able to realize: (1) the assessment of chemical regulations, and; (2) develop roadmaps towards CE activities (life cycle assessment), and CSR.

Table 1 – Conceptual framework of how a product stewardship action plan encompassing impacts of chemical regulations, CE and CSR could be implemented

Concept / Feature	Meaning
Identify internal actors.	Engage with all internal stakeholders such as design, purchasing, manufacture, quality, sales, etc. All stakeholders within a business need to be engaged. PS will then be able to allow effective reviews.
Agree actors.	Clearly identify who will be part of the PS panel. Actors need to be committed to attend, PS panel review meetings, and support the PS process.
Establish initial objectives	Review production stewardship, regulatory, CE and CSR literature. Brainstorm and set high-level initial goals.
Embed and engage to create a PS culture.	Embed PS panels in as many business decisions making processes as possible. This will require the actors supporting the PS process to engage with all related functions explaining the new PS culture being adopted.
Define more detailed objectives.	Develop a more thorough set of objectives. This will include setting clear targets: (1) on the use of regulated chemicals; (2) developing products which are more sustainable (materials and resources) and can feed into the CE; (3) defining a set of CSR objectives. The objectives should result in clear targets.
Gap analysis and roadmap.	Analyze the current state organization. Identify gaps which exist today, which prevent the objectives from being completed. Develop a roadmap of activities.
Identify external stakeholders.	Identify key external stakeholders to your organization who will be impacted by changes required by the action plan. Engage with stakeholders to provide insights of the proposed changes. Understand impacts of changes on external stakeholders. Review initial feedback, adjust the action plan as required.
Establish gated reviews.	Have a gated review process for key business processing stages. Establish key milestones for different functional areas within an organization to engage with

Concept / Feature	Meaning
	the PS panel for a review. These reviews will cover all aspects of business operations: • **Purchasing** - Apply criteria which assess supply chains in terms of sustainability, CE, CSR. Engage with your suppliers to get them to meet the criteria, who can help deliver sustainability, CE and CSR goals for your organization. • **Design** – Understand chemical substances in use. • **Manufacturing** – Ensure products are manufactured to meet your chemical regulations, sustainability, CE and CSR targets. • **Business operations** – Ensure business operations perform (sales, back-office, warehousing) operations to meet your chemical regulations, sustainability, CE and CSR targets.
Enforce gated reviews.	Ensure all relevant business decisions are reviewed by the PS panel.
Continuous improvements	Regularly monitor the changes reviewed by the PS panel. Adjust decisions and actions to align with chemical regulations, sustainability, CE and CSR targets.

4.2. Contributions to theory

- The role of industry is seen today as going beyond merely generating profits for stakeholders, but also to act as good corporate citizen, acting responsibly and adhering to chemical regulations.
- PS strategies must adapt to both increasingly competitive market places, whilst adhering to maintaining the balance between (1) reducing costs; (2) providing competitively priced products; (3) chemical regulations, and; (4) resultant drivers from sustainability, EPR, CE and CSR
- Embedding a PS mindset which can address the required actions within an organization takes a long to implement

4.3. Future research extensions

- A Delphi study to assess the real-world impacts of chemical regulations, CE and CSR on PS.
- Extended literature review to include a review of policy statements on chemical regulations, CE, CSR, on PS from several companies.
- Expansion of the conceptual framework shown in Table [1] to include a detailed set of tasks on implementing chemical regulations, CE and CSR into PS.
- Development of a framework for planning monitoring, assigning / controlling actions based on the Plan-Do-Act-Check model (Deming, 1986).

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