Environmental practices in UK breweries

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Abstract

This paper uncovers the motivations, practices, measurement and barriers to environmental sustainability within UK brewers. Whilst much of the current literature draws on the practices of the top companies, this paper looks across a single supply chain tier and looks at the realities for companies of all shapes and sizes. Through site visits and workshops a picture is created of how brewers are managing their operations and how they can enhance their environmental performance. A model is developed which captures the key factors that influence the uptake of environmental practices in the brewing sector. This model may have wider application.

Keywords: *Environmental practices, eco-efficient operations, organisational barriers, breweries*

Introduction

There is increasing attention to environmental performance both in practice and within the academic literature. Until now much of the academic work has until now focused on what leading companies achieve (e.g. Pagell & Wu, 2009). In the few papers that do not focus on leaders, research is typically on multiple sectors and uses survey or public data (e.g. Hajmohammad et al., 2013). Little work examines the same sub-sector, at the same supply chain tier and similar production systems (Rusinko, 2007).

This paper looks across a single supply chain tier and looks at the realities for companies of all shapes and sizes. Supported by the Brewers Research & Education Fund (UK), this project examines the reduction of environmental impact in manufacturing operations through the implementation of new practices. The work sought to uncover the motivations, measurement, practices and barriers of UK brewers. The sector growth, common structure and environmental impact make it an interesting sector for environmental research. Accordingly, what motivates a brewery to change, how they identify improvements, what practices they implement, what barriers they face and what outcomes they achieve can be compared easily.

In this paper the literature is examined to establish what is known about drivers for change, supply chain influence, environmental practices, green in the context of lean and barriers to environmental progress. This is used to establish gaps in knowledge and formulate the research aims. After a short introduction to the UK brewing industry, the methodology is presented to account for sampling, data collection and analysis. The

findings on UK breweries covering motivations, measurement, practices and barriers are presented. Finally, a novel model that captures how breweries adopt environmental practices is presented. Conclusions on the relevance to theory and practice complete the paper.

Environmental practice literature

It is well established that in the face of rising costs and concerns about raw material availability companies must strive for greater efficiency in both their operations efficiency as well as wider resource efficiency. Greater attention to the environmental imperative is driven by competitive behaviour as well as purposeful management (Bansal & Roth, 2000). Better management of production processes through eco-efficiency principles and reduce, reuse and recycling principles (Despeisse et al 2012) results in lower environmental impacts and lower costs (Kleindorfer at al 2005). The application of lean can indirectly lower environmental impacts (Florida 1996). Tools are needed to directly address both lean and 'green' (Kurdve et al, 2014), better manage that technology (Garetti & Taisch, 2012), and better manage wastes (Kleindorfer at al 2005).

The desire to reduce environmental impact of operations is driven by input cost, output cost, regulation, NGO activity and 'doing the right thing' (Bansal & Roth, 2000). In identifying the top drivers, Giunipero et al. (2014) cite management leadership and regulation as well as financial benefits, competitive advantage, certification and customer demand. Similarly, drivers can be internal (e.g. people capabilities) or external (e.g. supply chain) which pressurizes the supply base to follow (Seuring and Muller, 2008). There is the need for improved understanding of how firms behave environmentally to ascertain what factors induce environmental behaviour (Williamson, 2006). There has been significant focus on supply chains, but little work examines single homogenous tiers of supply chains to look at behaviour across similar companies with similar processes (Ruskino, 2007) especially small and medium-sized enterprises (Subramanian & Gunasekaran, 2015). Additionally, whilst there has been research on food and drink, in general there has been little on breweries, especially microbreweries (Danson et al, 2015).

Examples of eco-efficient practice are documented by life cycle stage (Despeisse et al (2012) and for the supply chain (Subramanian & Gunasekaran, 2015). They cover stages of production lifecycle, different resource types (energy, water, etc) and different approaches to reduction (remove, reduce, reuse, recycle). The different ways of expressing practices enables others to access them more easily depending on whether they are trying to improve a piece of process technology or reduce the consumption of a specific resource. Whilst there is a wealth of practice and application outcome information available (Ruskino, 2007), especially for leaders, there is an outstanding question of how these practices are deployed (Despeisse, 2012).

Lean manufacturing principles have potential to support environmental development by promoting flow and minimizing waste (Hartini & Ciptomulyono, 2015). Lean alone is insufficient to improve environmental performance [24] with many citing better performances when lean and 'green' are combined (e.g. (Hartini & Ciptomulyono, 2015). Interestingly Fercoq et al. (2016) challenge the availability of quality empirical evidence for the lean and eco-efficiency link despite the logical links and general acceptance of linking.

Process improvement approaches can identify improvement opportunities; however, barriers may exist to prevent progress. A barrier hinders efficiency improvements and has technical, organizational and external forms. Barriers include lack of environmental awareness, lack of environmental metrics, limited motivation, inertia, perception of

higher cost and lack of responsibility to name a few (e.g. Kurdve et al, 2014, Lunt et al, 2014). By understanding them, mitigating actions can help promote the implementation of better practice. Survey (e.g. Zhu & Sarkis, 2004) or open access data (e.g. King & Lenox, 2001) research is common but research on companies in the same industrial sector or supply chain tier is lacking.

The literature review identified gaps. Firstly, 'what' practices, especially technology, are deployed is well documented but 'how' they are adopted is less well understood. Secondly, there is little research on the types of barriers that can exist in a given industrial sector and how these can be overcome. Combining new knowledge of how improvements are made in operations with the existing work on practices would enable barriers and approaches to be better understood and in turn characterize how impact reduction can be advanced. The lack of understanding of how environmental practice is adopted led to the researchers posing the research question: "How can environmental practice be advanced in operations?" Brewing is a suitable sector for examining this question given the commonality of supply chain and brewing process.

The brewing industry

Brewing is a distinct global industry and the number of breweries is rapidly increasing. The UK has over 1,700 breweries (Simons, 2017), many of which are young and small. Brewers have a standard process and occupy same supply chain position between raw material distributors and onward distribution to retail and bars. Brewing is energy intensive and generates potentially valuable wastes (Sturn et al, 2012). An average brewery will use 0.48kWh energy and 4.4l water (BBPA, 2014) for each litre of beer with larger breweries typically more efficient than smaller breweries due to batch economies, more opportunity for heat exchange, etc. With the carbon footprint distribution typically including 39% ingredients, 25% brewery and 26% packaging and transport (BEIR, 2012), the brewery operation could have significant opportunity for savings.

As with any industrial sector there are recognised leaders in brewing and others aspiring to adopt environmental practices. Their different sizes mean potentially different supply chain pressures with respect to sustainable and environmental objectives of other actors. Accordingly, what motivates a brewery to change, how they identify improvements, what practices they implement, what barriers they face and what outcomes they achieve can be readily compared. Hence how brewers tackle the environmental challenge in their operations is worthy of research to guide industry generally.

Methodology

The research sought to understand how environmental practices are adopted in manufacturing operations. With little known about how operations adopt practices, a qualitative research approach was chosen to gather data from operations on how production systems are viewed through an environmental lens and what is holding them back. Data from multiple operations would provide both depth and breadth and so a single, homogenous tier of manufacturing with common production technology and common supply chain interfaces was chosen, namely UK beer brewers. The unit of analysis was the company production site and included supply chain interactions but excluded suppliers and customers (own retail, customer retail, hotels, etc).

Given such absence of literature in this field, including frameworks, it was necessary to empirically examine industrial practice to build knowledge. A grounded approach

using a process mindset was the means to capture why and how environmental actions are undertaken and in turn create a rich picture of practice adoption.

Two methods of data collection were used. First, one-to-one face-to-face interviews took place with brewers, typically at their production site. Interviewees had the role of head brewer, production manager or sustainability lead. Interviews were guided by themes from the literature, namely: what are the drivers for change (internal and external, including the supply chain), what process is used to guide improvement, what was implemented, what were the benefits and what were the barriers for change?

Open invitations (email, social media), direct (telephone) and indirect (through membership bodies) were used to make contact with brewers. No filtering on level of maturity of environmental progress was attempted, hence this work captures companies at any stage of their environmental work, not just those recognised to be leaders. Large, medium, small and micro brewers contributed to the research with a self-selecting bias towards smaller brewers.

Second, three half day workshops took place regionally at breweries to collect data on practices and barriers from typically 5-10 invited brewers in a group setting. Contact was by emailing all breweries within reach of the workshop locations (Glasgow, Huddersfield, Oxford) followed by telephone contact. Additionally, brewer membership and other support organisations broadcast the research project and events regionally and nationally. Stimulated by resource efficiency presentations, the brewers worked in groups to identify successes and challenges. This enabled prompted discussions around issues and allowed observations on the level of willingness to share and the acceptability of adopting practices from other companies. Collaboration and communities where not part of the planned data collection but were frequently evidenced in the interviews and workshops.

Data analysis was by initial coding and clustering according to motivations, benefits, practices deployed, and barriers encountered. Codes (e.g. a type of barrier or practice) were refined into final codes which are shown as the barriers, practices, etc in the tables and figures. An unexpected cluster formed around community. Metric and practice data was structured according to resource flow (e.g. energy, grain) and, or practice (e.g. reuse, minimization), by process stage (e.g. fermentation, filling) as per the literature classifications earlier. In clustering, no attempt was made to correlate relationships quantitatively as this would be more robustly addressed through survey. The clustered data (for example, the barriers to environmental improvement) was compared with literature. Sufficient commonality of approach was observed to justify the presentation of a model to capture what aids and what hinders environmental practice advance.

Findings

The data presented combines the motivations, challenges and practices from the brewers interviewed and workshop attendees. No company covered all areas but there were common metrics (e.g. water consumption per litre of beer), practices (e.g. spent materials to farmland, heat exchange) and values (e.g. social purpose and heritage).

Metrics and benefits

Common metrics were recorded for brewers (see Table 1). The level of granularity of metric varied with some measuring only at site level through to one with meters installed on each hose. Measurement was generally driven by cost control but there were instances of scarcity (geographical location or municipal capacity) or absence of incentive (landlord/tenant agreement where water costs are fixed).

Table 1. Typical metrics used and their alignment to production stage.

Input metric	Process metric	Output metric
Energy use	Energy use	Production
Water use	Water use	Carbon content
(both site level)	(specific processes)	Waste output

The benefits realized were grouped into cost reduction, material impact and external impact (see Table 2). Benefits were driven by a combination of desire to reduce cost and reduce environmental impact which were at times difficult to separate. Those who sought to reduce environmental impact in turn exposed themselves to a wider range of opportunities, e.g. reusing cleaning chemicals until exhaustion was triggered by the motivation to reduce environmental impact and implemented because it reduced cost.

Table 2. Benefits of environmental focus.

Cost reduction	Material impact	External impact
Purchasing	Resilience to scarcity	Brand presence
Operations	Value from wastes	Brand leadership
Disposal	Lower footprint	Market share growth
Defray upgrades		Collaboration opportunities

Resilience was cited several times either because of market (e.g. foreseen scarcity of American hops) or infrastructure (e.g. ability to draw more water). Benefits of environmental agendas to engage employees or gain customer recognition were cited demonstrating the strong values and purpose that many of these businesses articulated with a wish "to do the right thing" and reduce cost. There was less emphasis on market advantage and no mention of market/customer pull or supplier push.

Barriers

Brewers cited challenges in advancing environmental practice. The generic responses in Table 3 are clustered by finance, people, organization and process and tools. Short and long-term financial barriers were noted by many.

Table 3. Barriers cited according to aspect of the business.

Finance	People	Organization	Process & tools
Access to capital	Change culture	Inertia	Split incentive
Cash flow	Resources	Ownership	Selection challenge
	Training	Priority	Info availability
	Knowledge		Opportunity
	Risk		

With stable production and long-lasting equipment, technology introduction was infrequent. Further, the small brewers direct spend to short-term payback projects. Brewers reported achieving benefits without significant spend through operating practice change but recognized the limits with their current installed capacity. The

people barriers (relating to desire and ability) and organizational barriers (relating to benefit and impact) change were cited by all, ranging from having the capacity to enact change through to not having the customer pull. Many barriers relate to the lack of incentives or the inability to act, e.g. short-term use of another company's brewing equipment (gipsy brewing). The process and tools barriers (how to impact on the business) related to difficulties of technical change or the difficulties in achieving significant benefit. For example, some companies had low volumes, and none would risk impact on product quality.

Practices

The brewers volunteered a variety of common practices using either a process stage mindset (mash tun, fermentation, etc) or a resource flow mindset (ingredients, water, energy, etc). Figure 1 presents the main practices gathered by resource flow and by basic process stage of input, process and output. Greater granularity in the process stages is not shown as many practices are common for all process steps (e.g. data capture, process control, cleaning, etc). Some practices were universally adopted (e.g. heat exchange) whereas others were only adopted by those with economies of scale (e.g. bulk purchasing or anaerobic digestion). It was only the larger brewers that spoke of influencing the upstream and downstream supply chain.

The brewers referred to key inputs of materials, water, energy and packaging. Raw materials were grouped together except for water which was both a raw material and a general utility. Other practices related to people. Whilst many interviewees were exposed to both suppliers and customers, many of the practices are technological and relate to their own operation, i.e. they relate to how they could change their own processes to be more resource efficient. In small breweries, there is line of sight from raw material store to finished goods and waste collection. This inevitably influences lifecycle understanding but for those smaller brewers their lifecycle influence is weak.

Discussion

The brewers offered common metrics. Those who offered more granular metrics cited more practice improvements, however, the metrics would not intuitively lead to all the practices offered. It is proposed that it is the purposeful management and process knowledge are significant drivers in change, supported by the metrics.

Pressures from external actors did not feature significantly. Some brewers spoke of the marketing benefits, but this appeared more as an offering, rather than a market response. Resilience was a concern, but carbon footprint was seldom expressed. The larger brewers had upstream supply chain activity and all brewers demonstrated a focus on the internal efficiency, especially energy. In support, Danson et al. (2015) saw provenance as a market differentiator but not sustainability or environmental credentials.

The sector has a common production process and in workshops, brewers readily communicated detail without the need for context. In discussing improvements, the language of lean (process thinking, terminology, tools, etc) was absent but a lean practitioner would recognize the alignment to lean. This latter point is interesting for how those outside the brewing sector need use the efficiency language of brewers to communicate any principles from 'standard' lean and resource efficiency approaches.

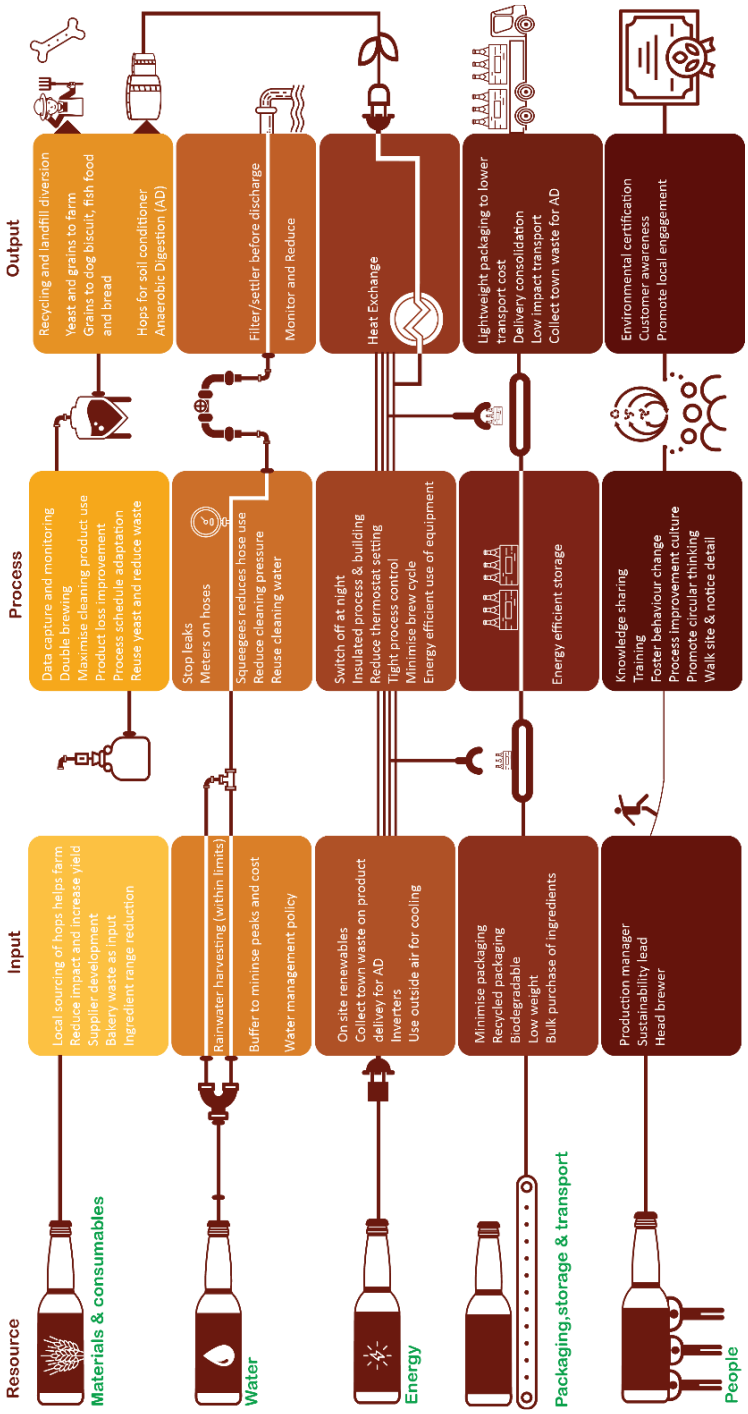

Fig. 1. Typical practices by material and activity categories.

The material and consumable flows are simple and waste from the process will be materials that have little perceived value (e.g. spent grain), however, some brewers challenge this (e.g. using hops in a second brew, using bread as an input, output used for bread). The water and energy supplies are not "visible" on input or loss, however, significant attention was given to these. Brewers sought to use less on input and extract further value on output. The level of attention given to these in breweries has potential for learning in other production systems, especially discrete, where these resources receive less attention and can be considered as 'free issue' on the shop floor.

In workshops, participants listened to practices used by others and considered directly implementing them. Helped by commonality of production process this does suggest endorsement is influential. Sharing is common in the sector and is supported organizations that communicate examples of good environmental practice. It is common to support cuckoo or gipsy brewing or allow other brewers in prior to starting up their own brewery suggesting a high level of collaboration and trust between brewers.

The barriers indicate where work is required to foster progress in environmental advance. Some brewers were early in their environmental journey and this could explain why many barriers identified related to people (Subramanian & Gunasekaran, 2015), their culture of change and their knowledge to undertake change. Small companies face challenges as acquiring specialist knowledge would temporarily lower production capacity. The barrier findings suggest that progress is enabled by people development but impacted by financial position and brewery infrastructure, which are compatible with Cherrafi et al. (2017) who identified knowledge, skills, leadership, costs and funding challenges.

Collating the justification, measurement, approach, practices, community and barriers from the above discussion and clusters of literature, a model for environmental practice advance is proposed (Figure 2). The model captures the key factors under each category that influences the take up of environmental practices. For example, the justification category to start environmental practice implementation contains the most influential factors found of values, impact, waste (resource efficiency), resilience, cost and brand. This initiates the application of a resource efficiency approach (which may be tempered by barriers) from which new practices are implemented that change input, process and output performance. Influencing the justification and approach is a community of practice that shares knowledge, practices and sometimes resource. The model was developed from a general knowledge base and findings from the brewing sector with potential for application in other sectors.

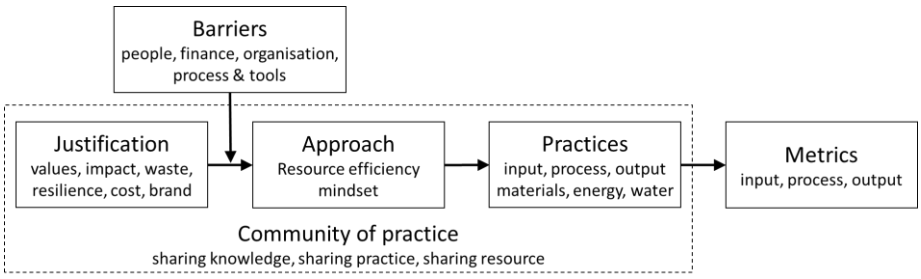

Fig. 2. A model of environmental practice change in UK breweries.

Research limitations can be identified and used to trigger future research. Firstly, the sample was from UK breweries. There is potential to consider other drink manufacturers (e.g. soft, gin, whisky and wine) and other countries. Secondly, with the growth in UK craft brewing, many of those in the sample were small companies. The willingness to collaborate according to size could uncover ways to instigate change in a given sector. Finally, there was no attempt to assess the maturity of brewers' sustainability journeys and it is likely that the journey stage affects the responses given by brewers.

Conclusions

Motivated by the lack of insight on how industry is advancing beyond prominent leaders, this paper provides insight into how environmental practice can be advanced in operations. The research addresses this gap in knowledge by proposing a model to capture the motivations of brewers, how they measure performance, what challenges to progress they encounter, what practices they favour and how their sense of community enables practice sharing. The theoretical contribution is characterizing how a common tier of similar potentially competitive companies adopt environmental practices. Importantly the research captures those motivated to improve rather than known leaders.

The implications for practice is a model that enables other manufacturers or their support organizations to improve adoption rates; the model characterizes where the challenges could arise, what practices could be potentially readily adopted and how communities of practices foster exchange of ideas. The data for this research contains a significant proportion of SMEs and the principles behind the practices adopted could be generically applicable. The research outcomes therefore have potential to impact on both brewing and wider industry beyond the food and drink sector.

Specifically, the paper documents the practices generally adopted by a sector alongside the barriers generally present. This provides insight to the types of practices that can be adopted and lays the foundation for work on mitigating barriers to improve practice adoption rate. Insight to the communities of practice to share non-product specific knowledge to aid improvement is new to the environmental practice field and the food and drink sector. Further, the sector operates principles that can be characterized by lean but that is not the language generally used by the breweries. This provides an opportunity to introduce the structure of lean thinking to such companies and provides important insight into how language is important in communicating new practices.

Contribution

For researchers, the work contributes knowledge on why companies, especially brewers, focus on environmental impact, what they implement, how they go about the changes and what prevents further change. For practitioners, the work presents a framework that includes common metrics that assess eco- efficiency activity outcomes. The learning on practice adoption can guide those in operations on how to improve resource efficiency and forewarn of barriers to prompt mitigating actions. The findings could be used to explain what will hinder wider general adoption and how this can be overcome rather than what enables leaders to advance further. Finally, the community that brewers foster provides insight to a possible pathway to wider industry advance.

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