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Water and Waste Assessment, Implications for Sustainable Production in Brewery Birra Peja

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ABSTRACT

Water scarcity and waste disposal become increasingly critical issues in many parts of the world, so it is important to analyze their impact on sustainable production practices. Brewery Birra Peja produces an impressive quantity of beverages each year, including 50 000 000 liters of beer, 2 100 000 liters of non-carbonated juices, and 800 000 liters of carbonated juices. However, this production process also generates a significant amount of water waste, with 485 120 000 liters of raw water being used in the process. The management of this water waste is an important environmental issue that the brewery needs to address to reduce its impact on the environment and ensure sustainable production in the future. Birra Peja could implement various strategies to reduce water waste, such as investing in more efficient production processes and equipment, reusing water in the production cycle, and treating wastewater before discharging it into the environment. Additionally, could explore the use of alternative sources of water, such as rainwater harvesting or recycled water, to further reduce their impact on the environment. The paper identifies the potential economic, social, and environmental implications of poor water and waste management in production processes. Finally, the paper proposes strategies for addressing these issues, such as improving resource efficiency, implementing circular economy principles, and adopting innovative technologies. Also taking steps towards sustainability and responsible water management can enhance the company's reputation and increase its appeal to environmentally conscious consumers. Overall, while Birra Peja's production output is impressive, it's essential to address the issue of water waste to ensure the sustainability of their operations and minimize their impact on the environment.

Keywords: brewery, wastewater management, sustainability, environmental impact, cost savings.

INTRODUCTION

The brewing sector is an important part of the global food industry and beer production plays a significant role in the sector's economic position. The annual worldwide production of beer exceeded 1.34 billion hectoliters in 2002 (FAO Source, 2003). Beer is the fifth most consumed beverage in the world, with tea, carbonated soft drinks, milk, and coffee being more commonly consumed. However, beer is still a popular drink, with an average consumption of 9.6 liters per capita among the population aged above 15. This suggests that beer remains a significant player in the global beverage market (OECD Health Data, 2005).

The brewing industry is known to use a significant amount of water for various operations such as processing raw materials, cleaning and sterilizing units, and producing the final beer product. The water is used in different areas of the brewery, including brewhouse, cellars, packaging, and general water use. In the brewhouse, water is used for mashing, lautering, boiling, and cooling the wort. In the cellars, water is used for the fermentation and maturation of beer, while in the

packaging area, it is used for the filling, labelling, and packaging of the final product. Apart from the water used in the actual production process, there is also water used for washing and cleaning equipment and facilities. This is done to ensure the quality and safety of the final product. The cleaning is often done using a process known as cleaning in place (CIP), which involves the use of chemical solutions and water to clean the vessels and pipes used in the production process. The use of water in the brewing industry is a major concern due to its impact on the environment. The large quantities of water used in the industry and the wastewater produced can have a significant impact on the quality of the local water sources. To reduce the environmental impact, breweries are adopting water conservation measures such as the use of water-efficient equipment, recycling of wastewater, and the implementation of wastewater treatment systems. By implementing these measures, breweries can reduce their water intake and the amount of wastewater they produce, thus minimizing their impact on the environment. As water and waste management are critical issues in the brewing industry, it is important to analyze their impact on sustainable production practices to ensure sustainable production and protect natural resources (Olajire, 2020; Martin et al., 2017; van der Merwe & Friend, 2002).

The ratio of effluent to beer production is an important indicator of the environmental impact of the brewing industry. Research has shown that the effluent load is often similar to the water load in the brewing process, as much of the water used in the brewing process ends up as effluent. In a study by Perry & De Villiers (2003), it was found that the effluent load was very similar to the water load, as none of the water used in brewing beer ends up in the final product. This means that most of the water used in the brewing process is discharged as effluent, which can have significant environmental implications. Therefore, it is important for the brewing industry to take measures to reduce water consumption and improve wastewater treatment to minimize the impact of their operations on the environment. By doing so, the industry can help to protect water resources and contribute to more sustainable production practices.

By adopting new brewing technologies that are more energy-efficient, the industry can reduce its overall energy consumption and minimize its carbon footprint. This may involve implementing measures such as heat recovery systems, using renewable energy sources like solar or wind power, and improving insulation in brewing equipment. By adopting water-saving technologies and reusing treated wastewater, the industry can reduce its overall water consumption and minimize the impact of its operations on local water resources. Preventing losses and reducing waste is another important component of sustainable production practices in the brewing industry. This may involve reducing packaging waste, optimizing production processes to minimize by-product generation, and implementing recycling programs to minimize the amount of waste sent to landfills (Danbrew, 2007; Walter et al., 2005; Robbins & Brillat, 2002).

Assessing water and waste management practices is crucial for sustainable development also in Kosovo. With a growing population and increasing industrialization, the demand for water resources is steadily increasing, while waste generation is also on the rise. The lack of proper waste management infrastructure in the country has led to environmental pollution and public health issues (Eurostat, 2021; EEA 2021; KEPA, 2021; MESP, 2019, 2013). In this context, companies like Birra Peja can play an important role in promoting sustainable production practices and reducing their environmental impact. By conducting a water and waste assessment, Birra Peja can identify areas for improvement and implement sustainable measures to optimize production processes and reduce waste generation.

The aim of the paper is to assess the current water and waste management practices at Birra Peja Brewery in Kosovo and analyze their impact on sustainable production. The paper also aims to provide recommendations for more sustainable water and waste management practices in the brewery.

MATERIAL AND METHODS

The study was conducted at Birra Peja, a brewery located in Peja, Kosovo. The brewery was chosen due to its significant contribution to the economy and its potential impact on the environment. The data was collected over 2022, every month (January – December). The sources of data collection included on-site observations, interviews with brewery personnel, and a review of existing data and records.

Water consumption was assessed by analyzing the monthly water usage records, including the sources of water and its allocation to different processes. Waste generation was assessed by analyzing the types and quantities of waste generated by different processes. The implications of water and waste management on sustainable production were evaluated by identifying the opportunities for improvement and potential strategies to reduce the environmental impact of the brewery. A sustainability assessment was conducted to evaluate the environmental, economic, and social impacts of the brewery operations and to identify potential areas of improvement.

Based on the findings of the study, conclusions and recommendations were developed to improve the water and waste management practices of the brewery and to promote sustainable production.

RESULTS AND DISCUSSION

The results of the water and waste assessment conducted at Brewery Birra Peja revealed some interesting findings. Regarding water consumption, it was found that the brewery used an average of 40426666 liters/per month. However, further analysis revealed that a significant portion of this water usage was attributed to the cleaning and sanitation processes. This highlights the need for more efficient cleaning processes and the potential for water savings.

Monthly water consumption in 2022 is presented in Table 1 and Figure 1.

As can be seen from Table 1 and Figure 1. from the annual expenditure, the summer months are more burdened with water expenditure, especially the month of August while the month with the lowest consumption is January. From this table, we can see that the consumption of water concerning production is 1 liter of production with 7.44 liters of water.

Table 1. Consumption per month of 2022

Month	Consumption, m^3
January	24160
February	40140
March	43710
April	27440
May	46090
July	55092
June	54968
August	59660
September	45280
October	33410
November	29510
December	25660
Total consumption	485120

In terms of waste management, the brewery was found to produce an approximately 0.14–0.20 kg of waste per liter of beer produced, which is relatively low compared to industry standards. The majority of this waste consisted of spent grains, hops, and yeast, which are commonly used as animal feed and fertilizer. However, it was also found that the brewery had a significant amount of plastic and cardboard waste that was not being recycled, indicating the need for better waste management practices in this area.

Breweries can achieve an effluent discharge of 3–5 m^3/m^3 of sold beer (exclusive of cooling waters). Untreated effluents typically contain suspended solids in the range of 10–60 milligrams per liter (mg/l), biochemical oxygen demand (BOD) in the range of 1,000–1,500 mg/l,

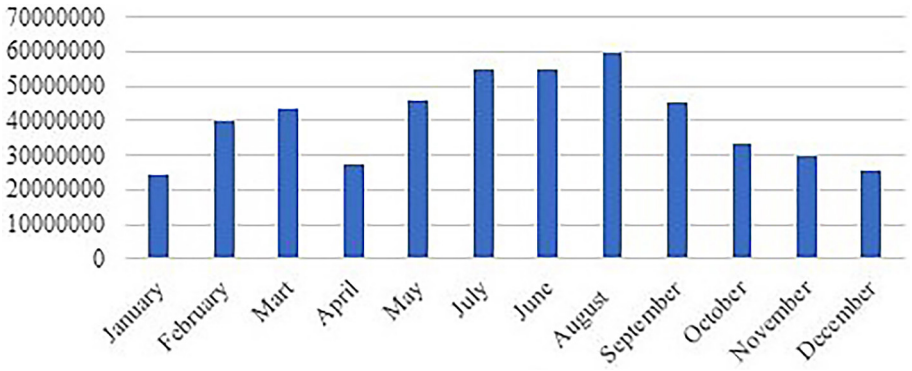

Figure 1. Consumption of water per month

chemical oxygen demand (COD) in the range of 1,800–3,000 mg/l, and nitrogen in the range 30–100 mg/l. Phosphorus can also be present at concentrations of the order of 10–30 mg/l. Effluents from individual process steps are variable. For example, bottle washing produces a large volume of effluent that, however, contains only a minor part of the total organics discharged from the brewery. Effluents from fermentation and filtering are high in organics and BOD but low in volume, accounting for about 3% of total wastewater volume but 97% of BOD. Effluent pH averages about 7 for the combined effluent but can fluctuate from 3 to 12 depending on the use of acid and alkaline cleaning agents. Effluent temperatures average about 30°C [Elshani et al., 2018, 2022]. Some data about water expenses in different stages of production in "Birra Peja" are presented in Table 2.

As can be seen from the table, we spend more water in the boiling process as well as in filling the beer. In these two places, water is used more as a technical medium. To address the issue of water waste at Birra Peja, the company could implement various methods and materials to reduce its water usage and improve its wastewater management [Brewers of Europe 2002; Brauer, 2006; Huige, 2006; USEPA, 2004, EEO, 1995]. Some potential methods and materials that could be employed include:

- Investing in water-efficient production processes and equipment: Birra Peja could invest in new equipment and processes that use less water, such as water-efficient cooling systems, high-pressure cleaning systems, and more efficient bottling and packaging systems.
- Reusing water in the production cycle: The brewery could implement a closed-loop water system that recirculates water through the production cycle to reduce water waste. This could involve treating and reusing wastewater generated during the brewing process [EC, 2019].
- Treating wastewater before discharging: Birra Peja could implement a wastewater treatment system that treats the wastewater generated during production to remove pollutants and contaminants before discharging it into the environment.
- Rainwater harvesting: The company could collect and store rainwater to use in production processes, reducing their reliance on freshwater sources.
- Recycled water: Birra Peja could explore the use of recycled water sources, such as municipal wastewater, which can be treated and used for non-potable purposes, such as cleaning and irrigation.

Table 2. Water consumption

Process step	Water consumption, m^3/m^3
Wort to whirlpool	2.0 (1.8–2.2)
Wort cooling	0.0 (0.0–2.4)
Fermentation cellar and yeast treatment	0.6 (0.5–0.8)
Filter and pressure tank room	0.3 (0.1–0.5)
Storage cellar	0.5 (0.3–0.6)
Bottling (70% of beer produces)	1.1 (0.9–2.1)
Barrel filling (30% of beer produced)	0.1 (0.1–0.2)
Wastewater from cleaning of vehicles, sanitary use, etc.	1.5 (1.0–3.0)
Steam boiler	0.2 (0.1–0.3)
Air compressor	0.3 (0.1–0.5)
Total	6.6 (4.9–12.6)

These methods and materials would require an initial investment but could lead to significant cost savings and environmental benefits in the long run. By reducing its water usage and managing its wastewater responsibly, Birra Peja could improve its sustainability and reduce its impact on the environment. Table 3. It's given an example that outlines the potential water usage and waste reduction measures for Birra Peja

By implementing these measures, Birra Peja could reduce its water consumption and minimize water waste, leading to environmental benefits and cost savings. The exact impact of each measure would depend on the specific implementation details and local conditions, but the table provides a starting point for identifying potential solutions [Brauer, 2006; Brewers, 2009].

In Table 4. we present data to provide a more detailed overview of the benefits and possible challenges related to the implementation of measures to reduce water waste in Birra Peja, helping interested parties to better understand the implications of these measures.

Table 3. The potential water usage and waste reduction measures for Birra Peja

Measure	Potential impact
Invest in water-efficient equipment	Reduce water usage during production processes
Reuse water in the production cycle	Reduce overall water consumption and minimize water waste
Implement a wastewater treatment system	Ensure that wastewater is treated before discharge into the environment and reduce environmental impact
Rainwater harvesting	Reduce reliance on freshwater sources and minimize water usage
Recycled water	Use alternative water sources to minimize water usage

Table 4. The potential benefits and challenges of implementing water waste reduction measures at Birra Peja

Benefit/challenge	Description
Benefit: reduced water usage	By implementing water-efficient equipment and processes, reusing water in production, and using alternative water sources, Birra Peja can significantly reduce its overall water consumption. This leads to reduced water bills, lower operational costs, and increased sustainability.
Benefit: improved environmental sustainability	By reducing water usage and minimizing wastewater generation, Birra Peja can reduce its impact on the environment, protect local water resources, and improve its reputation as a socially responsible business.
Benefit: cost savings	While the initial investment in water waste reduction measures can be significant, they can lead to significant cost savings in the long run. By reducing water usage, Birra Peja can lower water bills, save on the costs associated with wastewater treatment, and improve its financial performance.
Benefit: compliance with regulations	Implementing a wastewater treatment system and reducing water waste can help Birra Peja comply with local and national regulations and avoid potential fines or penalties for environmental non-compliance.
Challenge: upfront investment	Implementing water waste reduction measures can require a significant upfront investment, which can be a challenge for small or financially constrained businesses.
Challenge: maintenance and operation	Water waste reduction measures such as wastewater treatment systems require ongoing maintenance and operation, which can add to the operational costs of the brewery.
Challenge: technical complexity	Implementing water waste reduction measures can be technically complex, requiring specialized knowledge and expertise that may not be readily available within the company.

CONCLUSIONS

Based on the results and discussion, it can be concluded that the assessment of water consumption and waste in Brewery Birra Peja is essential for sustainable production. The study found that there is room for improvement in terms of water management and waste reduction, and implementing sustainable practices can have significant benefits for the environment, the community, and the company's bottom line. The assessment of water and waste management practices is crucial for achieving sustainable production in the brewery industry. The case of Birra Peja highlights the importance of implementing water conservation measures, such as the optimization of water use in the production process, the reuse of wastewater, and the implementation of efficient cleaning practices.

This study provides valuable insights and recommendations for Brewery Birra Peja and other breweries aiming to achieve sustainable practices. Furthermore, the case of Birra Peja also emphasizes the importance of stakeholder engagement and collaboration in achieving sustainable production by working closely with local authorities, suppliers, and customers.

Overall, the results of this assessment demonstrate the importance of conducting regular water and waste assessments in breweries to identify areas for improvement and promote sustainable production practices. The findings of this study suggest that implementing more efficient cleaning processes and improving waste management practices could lead to significant water and waste savings for Brewery Birra Peja, while also reducing its environmental footprint.

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