DIPONEGORO JOURNAL OF ACCOUNTING *Volume 15, Nomor 3, Tahun 2026, Halaman 1-9*
http://ejournal-s1.undip.ac.id/index.php/accounting *ISSN (Online): 2337-3806*

Improving Water Reduction Initiatives in Dishwashing Operations: A Case Study of Saxion University of Applied Sciences, Deventer

Stevan Ayub Sumbayak[1] **, Agung Juliarto**[2]
Department of Accounting, Faculty of Econnomics and Business, Diponegoro UniversityJl.Prof. Soedharto SH Tembalang, Semarang 50239, Phone: +6282135240978

ABSTRACT

This article examines how a viable and scalable business model can be developed to support water reduction initiatives in dishwashing operations at Saxion University of Applied Sciences, Deventer, as part of the university's broader target of reducing total water consumption by 20% by 2030. The study responds to the wider challenge of institutional water scarcity and the need for universities to translate sustainability ambitions into practical, financially grounded decisions. An integrated single-case study design was applied, combining semi-structured interviews with secondary operational and financial data. The analysis draws on four theoretical perspectives: Economic Evaluation Theory, Barriers and Feasibility Theory, Behavioral Theory, and Sustainable Business Model Theory. The findings show that although dishwashing appears theoretically relevant as a water-saving process, its empirical potential in the Saxion case is limited. The dishwasher had already been replaced with a newer adaptive machine, and dishwashing water consumption was not measured separately from building-level data. Consequently, the study could not produce a full standalone investment case or a robust financial evaluation of further dishwashing-specific improvement. The research nevertheless demonstrates that effective water-reduction decision-making depends on measurement availability, timing of intervention, and strategic scale, and it proposes two institutional policy actions: process-level monitoring and benchmarking, and a tiered water-reduction and procurement strategy.

Keywords: Water reduction; dishwashing operations; business model; cost–benefit analysis; water governance; sustainability

INTRODUCTION

Universities are increasingly expected to translate broad sustainability commitments into concrete operational actions. Saxion University of Applied Sciences has set a goal of reducing its total water consumption by 20% by 2030, a target that requires its Facility Services and Operations (FSO) department to identify which water-saving measures can deliver the strongest impact at a reasonable cost. Dishwashing operations in the Saxion Deventer canteen were selected as a candidate process for this study because water use in dishwashing is concentrated in a single, controllable operation, which in principle makes it easier to estimate, compare, and evaluate through cost–benefit reasoning.

Institutional water-saving decisions, however, are rarely determined by technical potential alone. Implementation is often constrained by economic and organizational barriers, including investment costs, operational complications,

[1]. *Author*
[2]. *Supervisor*

limited incentives, and behavioral resistance among users (Duong & Saphores, 2015). Without clear cost–benefit insight and a framework linking operational decisions to strategic sustainability targets, institutions struggle to convert high-level water-reduction goals into concrete action. This research problem motivates the present study: the absence of an evidence-based, financially informed business model that could guide Saxion in reducing water consumption within its dishwashing operations while remaining operationally feasible and economically justified.

The overarching question guiding this research is how a viable and scalable business model can be developed to support Saxion in reducing water consumption within its dishwashing operations, thereby contributing to the university's 20% reduction target by 2030 through cost–benefit analysis. Two sub-questions follow from this main question: first, what water-efficient dishwashing technologies, operational practices, and cost–benefit strategies have been implemented successfully in comparable institutional contexts, and how might these be adapted to Saxion's situation (Fane et al., 2020) and second, what economic, organizational, and behavioral barriers currently limit the implementation of water-saving measures in Saxion's dishwashing process, and how might these barriers be addressed through a structured business model (Avci, 2023).

This article reports the results of an integrated single-case study that combined interview-based process understanding with a scenario-based financial appraisal. The remainder of the article is organized as follows. Section 2 reviews the theoretical perspectives that inform the study. Section 3 outlines the research methodology. Section 4 presents the empirical findings and interprets them through the theoretical framework. Section 5 discusses the findings in relation to the research questions. Section 6 develops the policy implications arising from the case, and Section 7 concludes with the study's limitations and recommendations.

I. Theoretical Framework

Reducing water consumption in institutional dishwashing operations involves more than replacing equipment or encouraging users to consume less. For improvements to be effective and sustainable, an organization must consider the issue from financial, practical, behavioral, and organizational perspectives simultaneously. This section presents the four theoretical perspectives that guided the research design and the interpretation of findings.

1. Economic Evaluation Theory

Cost–Benefit Analysis (CBA) compares the cost of an intervention with the value it creates. In dishwashing operations, this involves considering the volume of water that can be saved, the cost of that water, the energy required to heat it, the cost of equipment upgrades, and the time required to recover the investment. Many water-saving measures have been shown to be financially worthwhile, particularly when they reduce demand rather than expand supply (Djukic et al., 2016). A relevant illustration comes from Stanford University's Wilbur Kitchen dishroom monitoring project, where replacing an older dishwasher with a more efficient model produced a 54% reduction in water use and a 64% reduction in energy use within the first month of monitoring (Stanford Water Resources, n.d.). Dishwashing is a useful test area precisely because water use is concentrated in a single process, which makes it comparatively easier to estimate and evaluate. In the present study, economic evaluation was operationalized through investment-oriented indicators, namely expected annual savings, payback period, return on investment, and net present

value, to support a scenario-based assessment of whether machine improvement would be financially worthwhile for Saxion.

2. Barriers and Feasibility Theory

Even when an intervention is financially attractive, implementation does not always follow. Prior research indicates that water-saving measures are frequently constrained by limited budgets, unclear organizational responsibilities, insufficient planning, or technical limitations (Sgroi et al., 2018). Dishwashing facilities have their own practical constraints, including hygiene requirements, loading procedures, cycle frequency, maintenance demands, and staff routines. Feasibility in this context therefore includes both technical and organizational dimensions: whether a more efficient machine would fit the daily workflow, whether staff could operate it effectively, and whether existing routines create avoidable water loss. This perspective justified the use of interviews in the present study, since numerical inputs alone cannot reveal whether a proposed improvement would be workable in daily practice.

3. Behavioral Theory

Dishwashing is partly a technical process and partly a behavioral one. The way dishes are loaded, whether they are pre-rinsed, which wash cycle is selected, and how frequently the machine is started all influence total water use. Behavioral science suggests that relatively low-cost interventions, such as reminders, feedback, or social norms, can shift water-use habits (Byerly et al., 2018). Complementary evidence indicates that financial motivations can sometimes be more effective than purely environmental messaging in encouraging conservation behavior (Avci, 2023). In this study, behavior was examined through interviews with kitchen staff rather than through a broad survey, allowing the research to focus on actual routines such as pre-rinsing, loading habits, and cycle timing, and on whether staff themselves regarded behavior or equipment as the more significant limitation.

4. Sustainable Business Model Theory

A business model describes how an organization creates, delivers, and captures value. In a sustainability context, value extends beyond financial return to include resource efficiency and long-term institutional benefit. Literature on circular and sustainable business models emphasizes reducing resource use and improving efficiency as central mechanisms of value creation (Sgroi et al., 2018). Within dishwashing operations specifically, circularity is expressed primarily through efficiency improvement rather than through closed-loop reuse systems. Value creation in this study could take the form of a more efficient machine or a better-organized workflow; value delivery could take the form of clearer procedures and appropriate equipment use; and value capture could take the form of reduced water and energy costs contributing to Saxion's 2030 target.

5. Integration of the Framework

Together, these four perspectives provide a coherent analytical basis for the study. Economic Evaluation Theory supports an assessment of whether machine improvement makes financial sense; Barriers and Feasibility Theory helps identify what may prevent implementation in practice; Behavioral Theory explains how staff currently interact with the dishwashing process; and Sustainable Business Model Theory organizes these insights into a structure suitable for managerial decision-making. This integrated framework justified both the interview-based and the investment-focused components of the research design described in the next section.

II. Methodology

1. Research Design

This study adopted an integrated single-case study design focused on the dishwashing operations of the Saxion University of Applied Sciences canteen in Deventer. The case was examined through two connected units of analysis: the current dishwashing process in daily practice, explored through interviews, and the financial attractiveness of machine improvement, assessed through secondary operational and cost data evaluated using investment appraisal tools such as net present value (NPV) and payback period. This design was considered appropriate because the study did not aim to produce broad statistical generalization across institutions, but rather an in-depth understanding of one operational process directly linked to Saxion's water-reduction target.

2. Data Collection

Two complementary data sources were used. Primary data were collected through semi-structured interviews with the kitchen manager of the Saxion Deventer canteen and a representative of Unica, the facility's technical operations partner. The interview guide proceeded from background questions, through a description of the current dishwashing workflow, to a judgment on whether procedural change or machine improvement represented the more realistic path forward. Secondary data were requested from Saxion's Facility Services and Operations and, where relevant, from supplier documentation, and were intended to include figures such as current dishwasher type and age, water and energy use per cycle, operating days per year, applicable tariffs, maintenance cost, and the purchase and installation cost of a replacement machine.

3. Population and Sampling

A purposive sampling strategy was used for the interviews, selecting participants who held direct operational and technical knowledge of the dishwashing process, namely the kitchen manager and the Unica Technical Operations Advisor. Purposive sampling was appropriate because the objective was an informed and credible understanding of one specific institutional setting rather than statistical generalization. For secondary data, no sampling was required, since the population consisted of all available operational and financial records relevant to the dishwashing process.

4. Data Analysis

Interview data were analyzed using thematic analysis, guided by the theoretical framework and the research question, with themes expected to include the current dishwashing workflow, operational inefficiencies, perceived strengths and weaknesses of the existing machine, and openness to procedural or machine improvement. Secondary data were intended to be analyzed through a scenario-based financial appraisal, in which annual water and energy savings would be estimated, net cash flow calculated, and payback period and NPV used as the primary investment appraisal indicators, with return on investment as a supporting measure.

5. Ethical Considerations

Participation in the interviews was voluntary, and respondents were informed about the purpose of the study and how their responses would be used. Where recording was not permitted, detailed written notes were taken instead. To protect privacy, respondents were not identified by name in the reporting of findings and were instead referred to by role.

III. Findings

1. Empirical Findings

The main empirical finding is that the dishwashing route at Saxion Deventer had already been partly addressed before the research could develop it further as a water-saving case. According to a written response received from the Technical Operations Advisor, Saxion had already replaced its previous dishwasher with a newer machine capable of adjusting the washing process to the level of dirt on the dishes, meaning that an appliance-level efficiency improvement had already been implemented. The response further indicated that the expected impact of additional dishwasher-related improvements on Saxion's broader water-reduction challenge would likely be limited.

A second finding concerns measurement. Saxion does not currently monitor dishwashing water use separately from building-level or main-meter data. As a result, no dishwashing-specific consumption figures were available, and the study could not establish a standalone baseline or a reliable dishwashing-only savings scenario. A third finding is that dishwashing is not treated as one of the major water-use priorities within Saxion's broader water-reduction strategy; larger opportunities are expected in areas such as toilet flushing and laboratory process water, and Saxion's water programme is increasingly oriented toward alternative water sources such as reused, rain, and drainage water. A fourth, more methodological finding is that the anticipated richness of primary evidence did not materialize in the expected form, since no meaningful dishwashing-specific data set became available beyond the institutional response already described.

2. Interpretation through the Theoretical Framework

Viewed through Economic Evaluation Theory, the logic of cost–benefit assessment remained theoretically valid but could not be fully applied, because no baseline estimate of current dishwashing water use was available and because the relevant machine replacement had already occurred, preventing a before-and-after comparison. The financial theory therefore remains sound, but the case did not provide the empirical inputs required to apply it in full.

Viewed through Barriers and Feasibility Theory, the findings indicate that the principal barriers in this case were not primarily resistance to change, but rather measurement limitations, scale limitations, and prior implementation. Feasibility, in other words, was constrained less by technical impossibility than by the fact that the relevant improvement opportunity no longer existed in an open, evaluable form.

Viewed through Behavioral Theory, the findings were limited: because no substantial interview-based behavioral evidence was obtained, the study could not empirically confirm whether staff routines contributed meaningfully to water inefficiency. The behavioral dimension therefore remains theoretically relevant but empirically unconfirmed in this case, and the resulting policy emphasis is placed more strongly on governance and measurement than on behavioral intervention.

Viewed through Sustainable Business Model Theory, dishwashing can no longer be positioned as the central route for achieving a significant share of Saxion's 2030 target. It instead serves as an illustrative example of an appliance-level measure that has already been taken, highlighting two broader lessons: that process-specific measurement is essential for evaluating local water-saving investments, and that not every theoretically relevant operational area becomes strategically important in practice.

IV. Discussion

Returning to the first sub-question, external literature and case evidence confirm that more efficient dishwashing machines, improved operational routines, and cost–benefit reasoning can lower water use in institutional and food-service settings (Fane et al., 2020). In the Saxion case, however, this type of machine-level improvement had already been implemented, which shifted the relevant question from what could be introduced toward what had already been introduced and what that implies for further action.

Regarding the second sub-question, the empirical evidence points to institutional and technical barriers rather than confirmed behavioral ones. These barriers include the absence of separate dishwashing measurement, the already completed machine replacement, and the comparatively limited strategic contribution of dishwashing within Saxion's wider water programme. The central issue emerging from the case is therefore not primarily whether the dishwashing machine should be further improved, but whether dishwashing offers enough measurable and scalable potential to justify treatment as a central strategic route.

With respect to the main research question, a fully developed dishwashing-specific business model could not be established on the basis of the available evidence, since the case lacked standalone measurement data and the key appliance-level improvement had already occurred. The findings nonetheless contribute a meaningful answer: dishwashing is not currently the most promising standalone route for advancing Saxion's 20% water-reduction target, and future strategic attention should be directed toward larger, more measurable water flows if substantial organizational impact is the objective. At a broader level, the case illustrates that effective water-reduction decision-making depends not only on theory, but on measurement availability, timing of intervention, and strategic scale.

V. Policy Implications

The policy value of the dishwashing case does not lie in demonstrating that dishwashing is the main route toward Saxion's 2030 target. Rather, it lies in revealing a broader institutional issue: water-saving ambitions cannot be translated into strong operational business cases when process-level data are missing, when the timing of intervention is no longer open, and when smaller operational sectors are not clearly positioned within the wider governance structure of water reduction. This interpretation is consistent with water governance literature emphasizing that effective reform depends on clear objectives, data transparency, and institutional capacity rather than on isolated technical measures alone (Grafton et al., 2019). It is also consistent with building water-benchmarking literature showing that conservation initiatives become more actionable once consumption is translated into process- or building-specific indicators (Flores, 2022).

1. Policy Action 1: Process-Level Water Monitoring and Benchmarking

Saxion should establish a process-level water monitoring and benchmarking policy under its wider Water Programme. At present, water data are monitored primarily at building or main-meter level, making it difficult to evaluate smaller operational sectors such as dishwashing in a financially meaningful way. A staged monitoring structure, in which selected operational sectors are gradually made visible through sub-metering, structured operational logging, or equivalent process-level estimation, would allow Saxion to translate operational data into internal benchmarks that support comparison and prioritization over time. The Wilbur Kitchen monitoring project demonstrates the practical value of this approach: by installing ultrasonic

water meters on a dishwasher, the project was able to distinguish different water uses within the machine and quantify a 54% reduction in water use following replacement (Stanford Water Resources, n.d.). Saxion need not replicate this exact approach, but the case shows that once measurement exists, process-level improvement becomes considerably more governable.

2. Policy Action 2: Tiered Water Reduction and Smart Procurement

Saxion should adopt a tiered water-reduction and procurement policy that separates water-use sectors into different strategic tiers. Tier 1 should include sectors with larger organizational impact, such as toilet flushing, laboratory process water, and suitable non-potable applications supported by alternative water sources. Tier 2 should include smaller, appliance-level processes such as dishwashing, which should remain part of institutional monitoring, procurement review, and performance assessment without receiving the same strategic weight as Tier 1 sectors. This tiered logic aligns with literature indicating that feasibility in water policy depends on a holistic balance of economic, technological, and social factors rather than on a single isolated measure (Sgroi et al., 2018), and with comparative evidence that conservation and reuse measures often need to be combined once conventional demand-side measures reach their limits (Keavney, 2022). Within this tiered approach, future replacement of dishwashers and similar indoor water-using appliances should be guided by minimum water-efficiency criteria, an approach supported by the Australian WELS experience, in which mandatory efficiency labelling for indoor appliances generated measurable environmental and economic benefit over time (Fane et al., 2020).

VI. Conclusion

This research set out to examine how a viable and scalable business model could be developed to reduce water consumption in Saxion's dishwashing operations. The evidence gathered shows that a fully developed, dishwashing-specific business model could not be established, primarily because the key machine-level improvement had already been implemented, dishwashing water use was not measured separately from building-level data, and dishwashing is not treated as one of Saxion's highest-impact strategic water-use sectors. This outcome does not indicate that dishwashing is irrelevant; rather, it indicates that the empirical conditions in the Saxion Deventer case were too constrained to support a strong dishwashing-specific investment conclusion. The study instead contributes an institutional lesson: effective water-reduction decision-making depends on measurement, timing, and strategic scale, not on theoretical relevance alone.

Several limitations affect the scope of these conclusions. The absence of separate dishwashing water-use data prevented the construction of a robust dishwashing-only saving scenario or a fully defensible financial case for further intervention. The fact that the main appliance-level intervention had already taken place before the research began meant that a conventional before-and-after investment comparison could not be developed, which made the study more reflective in character. The behavioral dimension could not be explored as deeply as originally intended, since the study did not produce strong behavioral evidence, so behavioral measures are treated in this article as complementary rather than central. Finally, the study is based on a single institutional case and therefore has limited external generalizability; the findings are directly relevant to Saxion Deventer and useful for Saxion University of Applied Sciences more broadly, but should not

automatically be transferred to other institutions without considering local measurement systems and governance arrangements (Sgroi et al., 2018).

Building on these findings and limitations, four recommendations are proposed. First, future water measurement and preservation efforts at Saxion should include dishwashing in water-flow mapping and monitoring, even though it is not currently one of the largest water-use sectors, since the absence of dishwashing-specific measurement was what prevented a proper evaluation of the process in this study. Second, dishwashing should be treated as a supporting component of the broader Saxion Water Programme rather than removed from institutional attention altogether. Third, future process-level water research at Saxion should be pursued only when a process still offers room for intervention, its water use can be measured separately, and its expected impact is large enough to justify detailed analysis. Fourth, Saxion's Facility Services and Operations should continue prioritizing larger, more measurable water-use sectors while gradually improving the visibility of smaller sectors such as dishwashing, so that the university's water strategy remains complete and smaller operational processes do not remain invisible in future sustainability planning.

References

Amarachi, A. S., Obumneme, A. E., Agbai, S. O., Abuka, C. O., Nwaogazie, F. O., Ajamu, P. S., et al. (2023). Sustainable water and wastewater management: Challenges, innovations, and lessons from global case studies. Path of Science, 9(9), 5014–5026.

Avci, İ. (2023). Sustainable water consumption and water-saving behaviours: A review of consumers' environmental and economic concerns in Turkey. Water and Environment Journal, 37(3), 616–627.

Byerly, H., Balmford, A., Ferraro, P. J., Hammond Wagner, C., Palchak, E., Polasky, S., et al. (2018). Nudging pro-environmental behavior: Evidence and opportunities. Frontiers in Ecology and the Environment, 16(3), 159–168.

Djukic, M., Jovanoski, I., Ivanovic, O. M., Lazic, M., & Bodroza, D. (2016). Cost-benefit analysis of an infrastructure project and a cost-reflective tariff: A case study for investment in wastewater treatment plant in Serbia. Renewable and Sustainable Energy Reviews, 59, 1419–1425.

Duong, K., & Saphores, J. D. M. (2015). Obstacles to wastewater reuse: An overview. Wiley Interdisciplinary Reviews: Water, 2(3), 199–214.

Fane, S., Grossman, C., & Schlunke, A. (2020). Australia's Water Efficiency Labelling and Standards Scheme: Summary of an environmental and economic evaluation. Water Supply, 20(1), 1–12.

Flores, R. A. (2022). Water benchmarking in buildings: A systematic review on methods and benchmarks for water conservation. Water, 14(3), 473.

Grafton, R. Q., Garrick, D., Manero, A., & Do, T. N. (2019). The water governance reform framework: Overview and applications to Australia, Mexico, Tanzania, USA and Vietnam. Water, 11(1), 137.

Keavney, E. (2022). A comparison of strategies used and considered to mitigate droughts in California. Applied Water Science, 12(9), 222.

Sgroi, M., Vagliasindi, F. G., & Roccaro, P. (2018). Feasibility, sustainability and circular economy concepts in water reuse. Current Opinion in Environmental Science & Health, 2, 20–25.

Stanford Water Resources. (n.d.). Fact sheet: Dishwasher water and energy monitoring at Wilbur Kitchen. Stanford University.