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"ANALYZING THE ECONOMIC VALUATION OF RECYCLED WATER"

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ABSTRACT

In some parts of the world, water reuse has been driven as an alternate water supply through considerations such as water shortages in arid and semi-arid regions, water security concerns in areas where water demand exceeds water availability, and rigorous and costly requirements for removing nutrients and contaminants from effluent release into surface water. This study has verified the success of measures of productivity, effectiveness and dependability for the determination of scheme performance throughout the different life cycle phases.

INTRODUCTION

Water is essential to people's lives and well-being and plays an important part in many economic sectors. However, due to human activity and economic development, water resources are distributed unfairly over time and under pressure. Agriculture represents about 70 percent of global uses of freshwater and up to 90 percent in some fast-growing nations. Food & irrigation Water is one of the most pressing supplies of freshwater. [1]

There have been many developments worldwide in the fresh water crisis. The agricultural sector, the largest user of water and 90% of the yearly demand of water, is exacerbating this problem. In recent decades, significant funding has been used on wastewater infrastructure. At the same time, the beneficial use of treated wastewater and the increasing stress on water resources have led to the development, as an essential element of the sustainable management of water resources, of the treatment of treated wastewater, also known as recycled water. [2]

Municipal waste water may be collected and used for irrigation in landscape and agriculture as water purification technology progresses. This new resource provides a true opportunity to augment the water supply safely and sustainably. It also guarantees a high level of supply reliability because of its ability to supply a constant quantity of water. Wastewater reuse has an impact on non-potable applications on the environment, society and economy. Nutrient capturing and fertiliser saving, improved soil microorganisms, improved soil conditions, higher crop yields, reduced salinity, the elimination of freshwater pumping as well as the lowering of the energy efficiency resulting from carbon footprint are all benefits that can arise from its agricultural use. [3]

Water reuse is practised in many countries for different uses, such as irrigation, landscape, irrigation of public space and golf courses, cooling of buildings, toilets to be refurbished, air-flow restoration and humidity areas to continue consuming water indirectly or restricting intruders of marine water through direct recharging in the aquifer. Water reuse efforts globally, in particular in regions where water resources are restricted, are growing increasingly popular. Most of the benefits are non-commercial and thus free of any charge. "Non-market" advantages are difficult to assess and are often ignored in traditional business research. [4]

Extended water re-use — the use of waste water for beneficial uses such as agriculture, industrial use and increase in drinking water – may significantly improve the country's total water supplies. Water Reusage presents a portfolio of treatment options available to mitigate water quality challenges and a new analysis suggesting that there can be no higher risk of exposure in at least a few current potable water treatment systems to certain microbial and chemical contaminants and that these risks may be orders in magnitude. [5]

LITERATURE REVIEW

DONG-PIL KIM, (2020) Mountain range (Jeongmaek) environmental value, connected to the Baekdudaegan mountain system in South Korea, is projected to address the shortage of environmental information. During 2011–2016, the questionnaire and contingent assessment method were used to examine seven Jeongmaek. The WTP for Geumbuk and Hannam-Geumbuk Jeongmaek was assessed to be lowest on the basis of readiness to make payments (WTP) for biodiversity, whereas Hanbuk Jeongmaek had a higher value of KRW 120,471. The level of education and the number of persons visiting appear to significantly affect these differences in WTP. [6]

Zenebe Gebreegziabher, Abebe D. Beyene, Fitsum Hagos and Alemu Mekonnen (2020) In this study the availability of irrigation waters may be measured by means of both an experiment (CE) and contingent valuation (CVM) in Ethiopia. In contrast to previous studies, this study combines current and unused water users with the same baseline state (standard quo) – no irrigation – and analyses the preferences of these two groups. The four features of the CE are the seasonal crop number, the seasonal watering frequency, crop kind and payment amount. Results show that the seasonal seasonal crop, seasone irrigation frequency, and crop type, respectively, was marginal for Birr 17.7 (US$ 0.98), 261.8 (US$ 14.54). and 87.6 (US$ 4.87). Our estimates of WTP farmers for hectare water irrigation systems range between Birr 738 ($ 41.00)(CE) and Birr 784 (USD 44.56) (from the CVM). We discovered that non-users, especially for the number of farmed seasons, were willing to pay in general compared with the current users. [7]

Patrodd Lloyd-Smith, Diane Dupont, Alfred Appiah, Wiktor Adamowicz (2019) This research assesses the monetary value of drinking water supply reliability in Alberta, Canada. We are using the online preferred survey results that gave respondents the expertise and numerical evidence for the future hazard of three water types of releases: short-term releases, long-term discharges and boiling water advice. Those who perceive a non-zero threat were given alternate options that reduce these dangers while improving water supply. As explanatory variables we have assessed the probability of sustaining the programmes using expenses and other programme features. The survey results indicate that there have not been many water failures in the last 10 years, but that interruptions are anticipated to be more frequent in the next 10 years. We calculated an average household preparedness (WTP) for payments of at least $71 per year for at least 50 percent reduced the likelihood of a short-term water disruption using the nonzero sample of respondents. Models utilising the responses of all respondents indicate a WTP of $46 annually, regardless of their risk estimate that lowers at least a 50 percent chance of short-term water disruptions. [8]

The Light of Cary, Madjid Bouzit, Sukanya (2018) This research has resulted to an extended database that may be used to assess, in particular reuse efforts, the social and economic impacts of waste water investment. A systematic and comprehensive evaluation of the current empirical studies, which analyse the individual readiness-to-pay (WTP) estimates of recycled waste Water, is provided. The results of 84 WTP trials of 22 international studies in 12 countries have been evaluated utilising a meta-analytic method (MA). We estimated the average WTP per household/year for recovered waste water to be USD 52.62 using our general meta-regression model. We demonstrate that WTP may vary systematicly and predictably from essential factors influencing WTP for recycled water to attitudes and perceptions regarding recycled water, such as socio-economic and contextual characteristics. We demonstrate that such variables are important for the future use of MA to transfer wealth. This finding may assist educate and guide research and development on future empirical evaluation studies, and facilitate the use of MA model value transfer methods. [9]

JAN F. KIVIET (2017) Singapore is subsequently affected by significant air pollution during periods of heavy forest and peatlands on neighbouring South Asian Islands. The causal relationship between Indonesia's fire intensity and air pollution (PSI) in Singapore and visits to health clinics in Singapore was simulated in the recently published American Economic Review. We find substantial deficiencies in the quantitative assessment of these relationships. The same conventional techniques and data are being used but also other methods of reducing the number of speculative assumptions are necessary. While more thorough information is required, some results seem to be more trustworthy. [10]

Economic Valuation of Recycled Water

Whatever is uncommon, and if you are economically well, you will choose more (Macmillan dictionary of Modern Economics). In developing countries such as India, wastewater is an economic advantage, but may not have one, since people don't choose more at the moment. But new technologies, limitations of fresh water and changes in attitudes may make waste water a profitable resource. Muir (2006) says waste water will remain limited over time as waste consumption or waste discharge decreases. According to him, authorities should prevent locking recycled water's low value uses, and establish allocative effectiveness measures. Recycled water economic assessment includes:

(1) The cost of producing and conveying recycled water versus the cost of other new water supply options,
(2) Reduced or delayed infrastructure costs,
(3) Improved reliability of supply, and
(4) Environmental benefits.

Three pillars of performance assessment

To grasp the key characteristics defining recycled water systems performance and to achieve agreement among the conflicting disciplines without generating imbalances or conflicts, a larger perspective is required of purpose, relevance, functionality, integrity, diversity, outcomes and accomplishment. The three main pillars of sustainable water and technology were emphasised in an extensive study of key technical, commercial, financial, economic, social and environmental problems. Productivity, efficiency and trustworthiness (Figure 1). It goes beyond traditional production and production to take these factors into consideration. It encompasses resources, technology, skill, efforts, major business processes, decision making and dynamics.

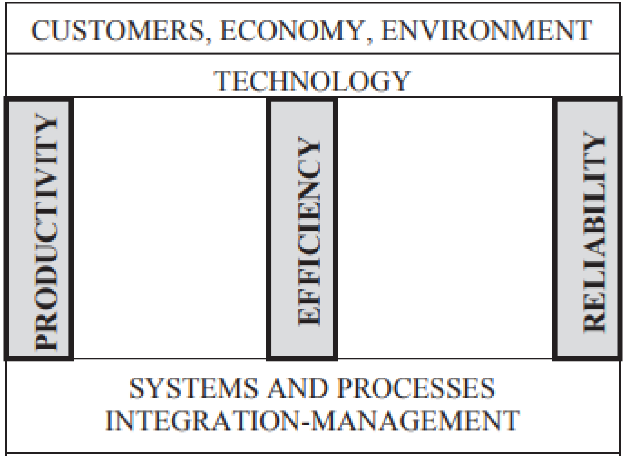


Figure 1: Three pillars of performance assessment

Each column has its own explanation of the goal and its meaning for the outcomes expected. These three pillars not only identify the quality or the significant impact of current performance, but provide possibilities for continuous development and benefit. In the performance evaluation of water reusable systems, the present fragmentation created a certain degree of ambiguity and needless conflict, primarily as social and environmental advantages are frequently rejected while technical and commercial objectives remain the primary focal point. The three-pillar performance assessment method allows a thorough cost, benefit, risk and reward analysis. This way the opportunities to execute a number of goals simultaneously and to assess the water cycle as a whole system would be raised.

Model of productivity

Productivity is an indication of how resources are converted into merchandise and may be expressed as partial and multifactor activities. The manufacturing process includes other products, such as waste streams. In the context of an environmental assessment, however, they may be assessed independently.

An analysis of system performance changes is to create a productivity model for reclaimed water (growth or decrease). The main production inputs and outputs and correspondence with the operation of the real system must be taken into account. A simple profit and loss statement is often used for a snapshot depiction and modelling. Even if reduced, it comprises, without losing any correct measuring position, of a real situation and in particular of changes in the output-output mix between the two periods. In fact there are numerous products, inputs and outputs involved, but in these studies the logic of measurement does not differ. In the context of the productivity analysis five metrics emphasise return on investment in the development of the life cycle cost approach (LCC).:

(i) Cost of capital,
(ii) Capacity treatment;
(iii) Rate of use of technology;
(iv) Resources of water and market, and
(v) Unit recycling costs and market; (Figure 2)

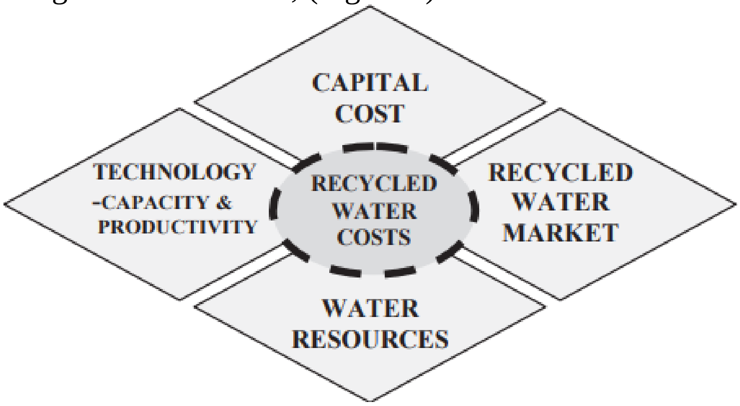


Figure 2 Drivers of recycled water productivity

Although it is generally known that the concept of productivity development is economically advantageous, a precise description may be quite challenging. It originates from a specific amount of input resulting from the output. As a result, productivity growth is expected to raise the output that may be produced at a given input level or reduce the input (and perhaps expenses) needed for the production predicted. In that regard the increase in productivity has been positive; the efficiency of production has been enhanced in order to accomplish more products with limited available resources. In the following formulation, the relationship between the aforementioned components is shown:

$$P = \frac{\text{profit}}{\text{total investment}} \times \frac{\text{revenue-costs}}{\text{output}} \times \frac{\text{output}}{\text{capacity}} \qquad (1)$$

where recycled water cost = (capital recovery costs + O&M costs)/productivity of recycle water plant in kL/y); capital recovery = debt and equity cost; and O&M cost = total LCC.

Economic efficiency model

Efficiency is a relative category, and it may not be sufficient to calculate if and how much it costs on the basis of a single formula. The cost-effectiveness calculation equation is as follows:

$$\mathrm{EFF}_{\mathrm{Co}} = \frac{\mathrm{Co} + \mathrm{C}_{\mathrm{M\&O}}}{\mathrm{Q}_{\mathrm{RW}}} \qquad \textbf{(2)}$$

where $\mathrm{EFF}_{\mathrm{Co}}$ = cost efficiency index; Co = capital costs; $\mathrm{C}_{\mathrm{M\&O}}$ = maintenance and operating cost; and Q_{RW} = recycled water production.

The sensitivity analysis would reveal that capital expenditure, M&O costs and production were dependent as an indication of efficiency in this case (EI).

The impact on EI of capital investment on production, maintenance and operating expenses is reduced. High spending on capital may also be driven by procurement procedures and technological progress, as opposed to relatively new or developed technologies, which are readily available on the market.

Cost benefit analysis (CBA) is the key tool for economic efficiency. Recycled water projects not only involve new investments in capital, infrastructure, buildings and equipment, replacement investment, but also the necessary manufacturing resources, materials and energy. The cost and benefit analysis of these components should take place throughout a lifetime. CBA utilises Discounted Cash Flow (DCF) analysis based on preset project discount rates. The formula of the CBA is as follows:

$$\mathrm{CBA} = \frac{\mathrm{NPV_B}}{\mathrm{NPV_C}} \qquad \textbf{(3)}$$

$$\mathrm{NPV} = \sum_{0}^{t} \frac{B_t - C_t}{(1+r)^t} \qquad \textbf{(4)}$$

where NPVB – net present value of benefits; NPVC – net present value of costs; B_t – benefit at time t; C_t – cost at time t; and r – discount rate.

CBA as the preferred method is used as the main reasons:

- I can evaluate initiatives, irrespective of their size, on a same basis;
- it enables planners to examine the project life at length;
- Provides a scientific evaluation of initiatives that for all practical reasons are appropriate.

The cost advantage assessment depends on a variety of variables, which may affect the accuracy of the outcome. Almost all assessment methods are typical of this. Key assumptions and sensitivity analysis should be included in order to enhance the accuracy of this process. The key hypotheses are:

i. First investment costs, periodic upgrades to substantial amounts, materials, energy and labour prices may change the market and

ii. Discount rates affecting the NPV analysis and the life cycle cost of it.

The CBA method for the evaluation of recycled water systems and taking them into consideration is based upon important criteria:

- The cost benefit ratio should be higher than 1 (1) and should show that the net cost benefit of a particular project is greater than the benefit of the associated expenditures.

- NPV calculation is suggested since it is straightforward and easy to use. The entire NPV of a project must be above zero. There are other general rules, though.
- CBA shall be executed in cash. All the cash capital costs are taken into account at the time of purchase in the analysis so that the product is fully depreciated over the project life.
- Depreciation is a charge not to be included in the CBA in cash (cost). This would be a kind of double counting, since the whole amount is acknowledged at the time of purchase.
- The CBA cash flow also omits interest payments since they are represented implicitly in the process of discounter.

Economic reliability analysis

Reliability and economy throughout the whole life cycle of the project, from the initial concept through execution and functioning, are closely linked. There are many facilities under construction that concentrate on minimising the risk of faults via rounding facilities, such as processes, electrical and mechanical equipment. Redundancy seldom stops, but may result in production losses or costly substituting costs.

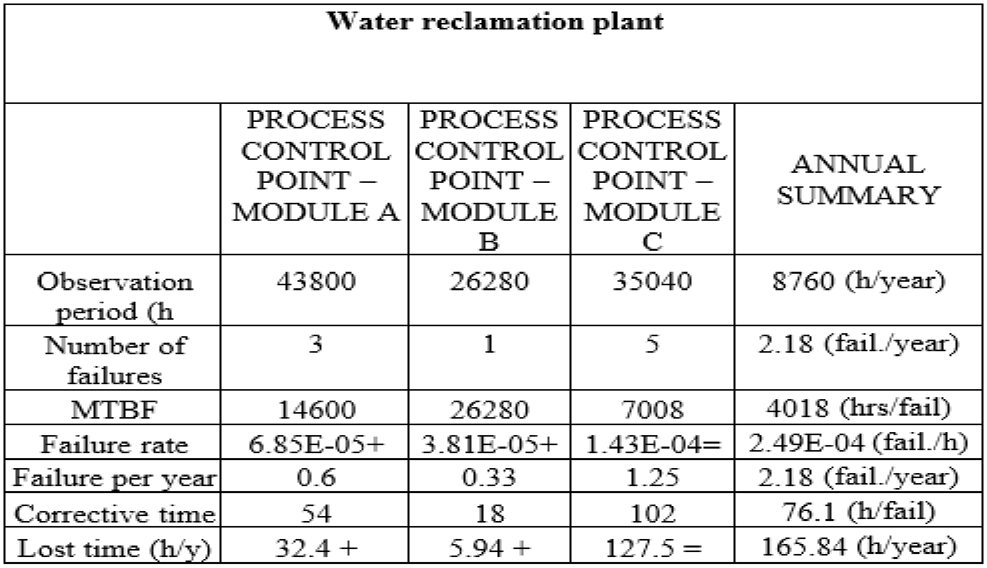
The reliability analysis and life-cycle costing may increase performance and minimise the risk of failure to assess water remediation technology performance over time, and to estimate the total costs of various management approaches. The consistent approach to the usage of costing techniques is a key factor to conduct these assessments. Two main concepts exist:

(i) The time value of money and
(ii) Decision, which costs are included/excluded.

The temporal value of the money is connected with changes in the real value over time and the discounted cash flow idea may be effectively addressed (DCF). Practically speaking, it should allow the decision maker to differentiate between a more reliable and costly system.

The mean time between failure, fault rate and time loss for a traditional water recycle system comprising of biological treatment, membrane filtering process and water pumping system recycling is summarised in Table 1.

Table 1 Water reclamation plant MTBF, failure rate and time losses.



Water reclamation plant				
	PROCESS CONTROL POINT – MODULE A	PROCESS CONTROL POINT – MODULE B	PROCESS CONTROL POINT – MODULE C	ANNUAL SUMMARY
Observation period (h	43800	26280	35040	8760 (h/year)
Number of failures	3	1	5	2.18 (fail./year)
MTBF	14600	26280	7008	4018 (hrs/fail)
Failure rate	6.85E-05+	3.81E-05+	1.43E-04=	2.49E-04 (fail./h)
Failure per year	0.6	0.33	1.25	2.18 (fail./year)
Corrective time	54	18	102	76.1 (h/fail)
Lost time (h/y)	32.4 +	5.94 +	127.5 =	165.84 (h/year)

Second, the assessment of costs and the decision of what to include and omit from analysis are affecting reliability analysis. What expenditure is related to process reliability and used in the costing survey is very important to differentiate clearly. The created rule is based on an economical approach. In other words, the assessment horizon is lowered simply as a cut-off to direct costs.

These expenses should be linked directly to the activity that requires the time, work and material needed for the repair of components essential for the system to operate. Reliability evaluations may include costs incurred as a consequence of the failure that have been justified directly. For a particular technology and process operation, this technique may offer accurate and complete pricing.

CONCLUSION

For a circular economy perspective, recycling and reuse are important and offer a means of better water supply management. Water reuse is confronted with numerous public perception barriers to prices and regulatory problems which may be addressed more effectively from a wider circular economy perspective. This article offers a scientific approach to water recovery and performance. Econometric models include productivity, efficiency, and reliability. Current data performance measures have been developed and utilised for economic research. This technology has an advantage in comparison with fragmented and contextual variables that it can provide an accurate performance and cheaply represent it throughout a life cycle.

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