

**REDEFINING OPERATIONAL EXCELLENCE IN EFFLUENT TREATMENT  
PROCESS WITH ZERO LIQUID DISCHARGE: MSME ENTREPRENEUR'S  
DECISION-MAKING STRATEGY ON DIGITAL TRANSFORMATION AND THEIR  
EMOTIONAL INTELLIGENCE**

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**Abstract. Purpose:** The world aims to achieve zero liquid discharge since industrial effluent collection increases daily. This paper focuses on current entrepreneurs' decision-making strategy on digital transformation and their emotional intelligence and proposes a model to achieve zero liquid discharge to mitigate ecological issues.

**Design / Methodology/approach:** This paper uses the data collected from thirty-two effluent treatment projects and services from twenty-two operating companies across the world, and the data was analyzed through JAMOVI.

**Findings:** Researchers found that correlation is stronger between ZLD and operational excellence, digital transformation and emotional intelligence. Correlation is negligible between ZLD and entrepreneurs decision making strategies and it needs to be improved.

**Research, Practical & Social Implications:** Researchers found that output achieves 97% recovery at the maximum level through zero liquid discharge system based on reject management with required COD (Chemical oxygen demand) and BOD (Biochemical oxygen demand). Entrepreneurs' emotional intelligence and digital transformation decision-making strategies provide zero liquid discharge through an evaporator system, gas extraction and crystallization. Researchers found that operating companies utilize sludge to fill the land for agriculture and biogas generation purposes, and operating companies utilize recovery water to reuse, recycle, garden, and discharge to the ocean which needs to be avoided completely.

**Originality / Value:** Based on existing research, to the author's knowledge, this research could be the first to examine the effluent treatment process with operational excellence on zero liquid discharge based on the Entrepreneur's decision-making strategy, digital transformation and emotional intelligence.

**Keywords:** Effluent treatment, Operational excellence, Zero liquid discharge, Entrepreneur, decision-making strategy, emotional intelligence, Digital transformation.

### **Introduction**

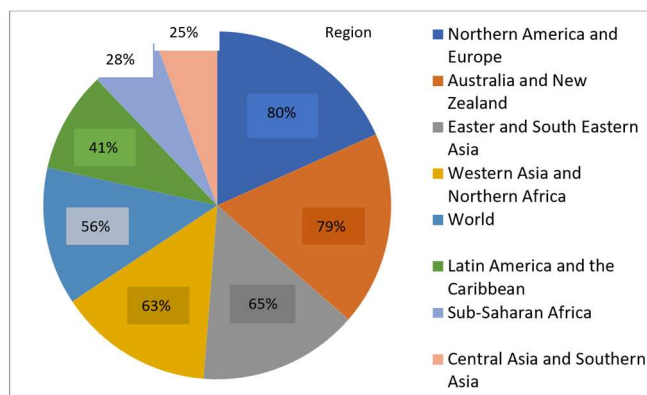
The world has to comply with sustainable development goals as per WHO and UNICEF by ensuring global effluent water is safely treated completely by 2030. Many industries such as solar industry, petrochemical industry, Pharmaceutical industry, Chemical industry, Textiles industry, Steel industry, power industry and medical sector produces a lot of effluents which should be safely treated with zero liquid discharge. Based on the present scenario, researchers observed that operating companies dilute zero liquid discharge based on fit for purpose strategy and MSME

entrepreneurs decision making strategies. Entrepreneur utilizes digital transformation with new innovative technologies through emotional intelligence to achieve operational excellence. Entrepreneur understands client requirements for implementation zero liquid discharge with the maximum level of 97%. A well-structured questionnaire and interviews were carried out to collect the responses from thirty two projects from twenty two respondents from MSME entrepreneurs. Researchers used convenient sampling to collect the data from respondents. The statistical tool used in this study is JAMOV, and data was analyzed through descriptive statistics, Reliability analysis, correlation and multiple regressions. Researchers analyzed and observed that zero liquid discharge could not be achieved completely with the lag of MSME entrepreneurs decision making strategies. Researchers recommended that operating companies should achieve 100% zero liquid discharge. Hence government and MSME entrepreneurs update their policies for continuous monitoring and controlling on the effluent discharge and to implement the plants with zero liquid discharge not only on the paper and also zero effluent discharge from the plant outlet.

## 1 Definition, and Literature review

### 1.1 Effluent treatment plant

Effluent treatment plant is more complex, non-linear and many uncertainty parameters to have right BOD and COD at the product outlet. Desalination plants and effluent treatment plants play a vital role in addressing the zero liquid discharge and fresh water scarcity in various plants such as solar industry, petrochemical industry, Pharmaceutical industry, Chemical industry, Textiles industry, Steel industry, power industry and medical sector. To attain sustainable water management, renewable energy sources need to be incorporated into desalination plants [1]. For achieving environmental sustainability, effluent from medical sector treated safely by proper handling of municipal solid effluent and treated sludge and biosolids may lead to a viable energy source [11]. Integrated solid effluent management planned for short term and long term goals to mitigate pandemic situation by overcoming artificial intelligence and Machine learning techniques [17].



**Fig-1: Global effluent (waste) water safely treated by region (Source: WHO, UNICEF, UN-Water).**

## 1.2 Redefining operational excellence

The first and foremost concern in effluent treatment plant is to control the concentration of BOD and COD at the plant outlet below some threshold or upper limit. BOD and COD can be optimized with efficiency of operation by selecting the correct control strategies [4]. Zero Liquid Discharge system drivers are originated from the stricter environmental regulations, clean water scarcity and high cost of effluent water treatment and disposal [9]. Many effluent treatment plants are not provided with measurement and control equipments along with controller design. Performance is improved by the use of a variable dissolved oxygen set point and it assures the decreasing of the amount of energy in the deficiency part and the increase of the effluent quality in the yield part [10]. Municipalities reduce their spending and optimize their resources while running effluent management processes based on smart effluent management system [12]. Based on the measurement of efficiency of autonomous vehicles for garbage collection is sufficiently efficient [16]. For handling complex non-linear problems, Artificial Intelligence can handle these problems and has become a powerful tool for exploring and managing effluent water treatment systems [18]. Artificial intelligence provides operational excellence achievement by eliminating the barriers and motivates the driving forces [20].

## 1.3 Digital Transformation

Digital twin in manufacturing improves industrial environments compare to Digital model and Digital Shadow [21]. Understanding and creating better entrepreneurial decision making and the adoption and usage of modern technological equipment to remain competitive are important [2]. The deployment of mobile robotic system will propel the world towards the goals of autonomous waste collection and disposal [3]. Entrepreneurs can develop, design and scale organizations through Artificial Intelligence and other interrelated industry 4.0 technologies such as Artificial Intelligence, Machine Learning, Cloud computing, blockchain and quantum computing [5]. Organizations need to deem carefully the extent information shared with decision makers for evaluating Artificial intelligence and Machine learning decisions [7]. Solid waste generation has been continuously increasing and Artificial intelligence technologies are required to enhance the smart and sustainable solid waste generation for improved recovery infrastructure and appropriate adoption [8]. Compared to human drivers, autonomous vehicles could drive in darker environments and artificial lightning could be partly remove and also reduce the power generation emissions [14]. Artificial intelligence based intelligent automation would prove in terms of increasing customer satisfaction [15].

## 1.4 MSME entrepreneur's decision making strategy and emotional intelligence

Entrepreneurs' decision-making styles differ from analytical, conceptual, directional, and behavioral to achieve the corporate goal. The decision making process in business engages understanding the trends and pattern in business growth, which are supported by data [2]. For achieving personal, group and organizational goals, the regulative effect of emotions shows that

emotions can be actively used. Emotion regulation can lead to uncontrollable negative and surprising outcomes for strategic actors who come across as inauthentic. On the contrary, strategic actors can create commitment and reduce emotional turmoil on and across all levels in an organization who express authentic emotions [6]. The main driver of waste separation is autonomous motivation based on the psychological states approach [13]. To achieve zero liquid discharge and zero waste landfills, proper training and direction to mitigate the lack of guidance for handling waste [19].

## 2 Research Methodology

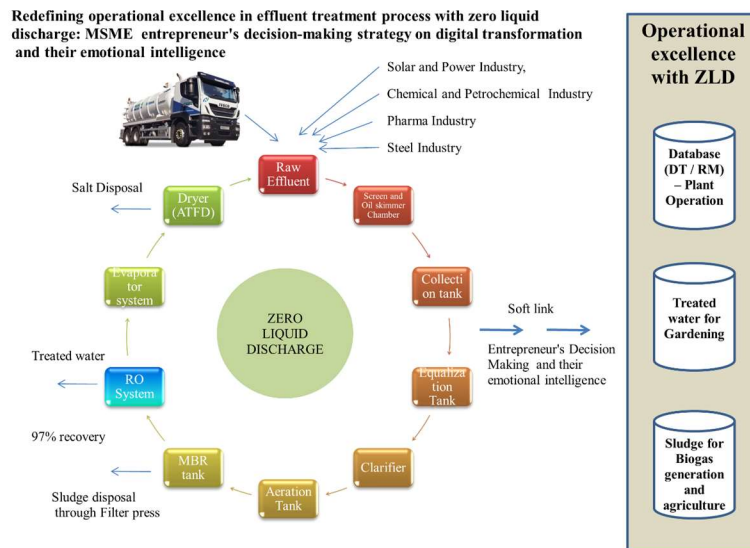
Researchers analysed the data through JAMOVI. A well-structured questionnaire and interview were conducted to collect the responses from thirty-two effluent treatment projects and services from twenty-two operating companies across India from MSME entrepreneurs.

Researchers used convenient sampling to collect the data from respondents. Researchers analysed the data through descriptive statistics, Reliability analysis and correlation, and multiple regressions.

This paper's primary goal is to achieve 100% Zero liquid discharge (ZLD) through effluent treatment process with operational excellence on zero liquid discharge based on the Entrepreneur's decision-making strategy, digital transformation and emotional intelligence. Fig. 2 represents the proposed model for the redefining operational excellence in effluent treatment process with zero liquid discharge through MSME entrepreneur's decision-making strategy on digital transformation and their emotional intelligence.

H0: Operational excellence, Digital transformation along with emotional intelligence is positively correlated with effluent zero liquid discharge.

H1: Entrepreneurs decision making strategies are negligibly correlated with effluent zero liquid discharge.



**Fig-2: Model for operational excellence in effluent treatment process with zero liquid discharge through MSME entrepreneur's decision making strategy on digital transformation and their emotional intelligence.**

### 3 Analysis

Researchers used JAMOVI for data analysis and variables used for this analysis are Redefining operation excellence (RDP), Entrepreneurs decision making (EDM), Digital transformation (DTF), Emotional Intelligence (EI), and Zero liquid discharge (ZLD).

Researchers received thirty-two effluent treatment projects and services from twenty-two operating companies across the world from MSME entrepreneurs through questionnaires and interviews.

Researchers have examined the variables through Cronbach's alpha reliability test to see if multiple choice questions through Likert scale surveys are dependable. The obtained value is 0.798 (Refer to Table 1), which is more than 0.7, which implies that the scale's internal consistency is good and valid. Hence, the items in the Likert scale are reliable for entrepreneurs to respond to the analysis.

**Table-1. Reliability scalability test**

Scale Reliability Statistics	
	<b>Cronbach's <math>\alpha</math></b>
scale	0.798

**Table-2. Frequency of Gender**

Researchers observed that among thirty two entrepreneurs' responses, thirty two (100.0%) entrepreneurs responded are Male and female entrepreneurs responded are none (0%) (Refer table-2).

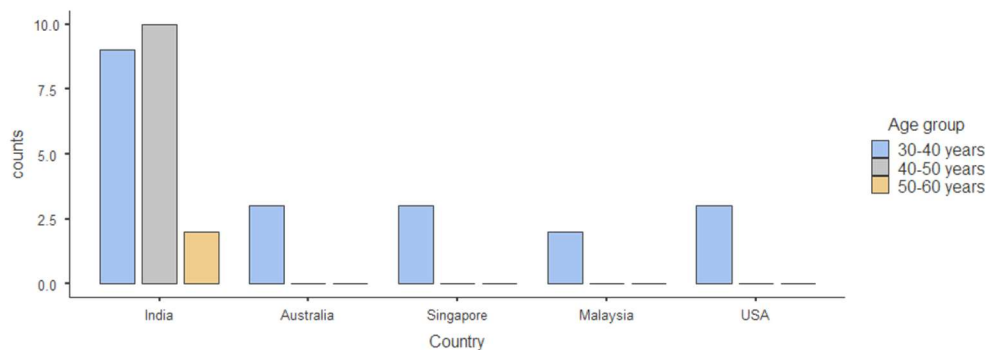
Frequencies of Gender			
<b>Gender</b>	<b>Counts</b>	<b>% of Total</b>	<b>Cumulative %</b>
Male	32	100 %	100 %
Female	0	0 %	100 %

The global waste water industry looks for mainly fit for purpose implementation with the latest innovative technologies along with their preparatory design. Digital transformation and innovative technologies are those catalysts to make the operational excellence to achieve zero liquid discharge. The geographical representation of entrepreneurs who participated in this analysis is given below. Based on the study, country-wise zero liquid discharge providers are given in the table, and a graphical representation is in Table 3 and Fig. 3 below.

**Table-3. Country-wise entrepreneurs response**

Frequencies of Country

Country	Age group	Counts	% of Total	Cumulative %
India	30-40 years	9	28.1 %	28.1 %
	40-50 years	10	31.3 %	59.4 %
	50-60 years	2	6.3 %	65.6 %
Australia	30-40 years	3	9.4 %	75.0 %
	40-50 years	0	0.0 %	75.0 %
	50-60 years	0	0.0 %	75.0 %
Singapore	30-40 years	3	9.4 %	84.4 %
	40-50 years	0	0.0 %	84.4 %
	50-60 years	0	0.0 %	84.4 %
Malaysia	30-40 years	2	6.3 %	90.6 %
	40-50 years	0	0.0 %	90.6 %
	50-60 years	0	0.0 %	90.6 %
USA	30-40 years	3	9.4 %	100.0 %
	40-50 years	0	0.0 %	100.0 %
	50-60 years	0	0.0 %	100.0 %



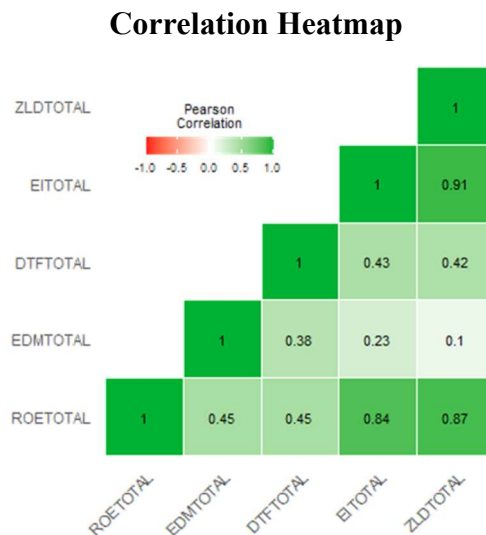
**Fig-3: Thirty two entrepreneurs’ responses from the India, USA, Australia, Singapore and Malaysia.**

Entrepreneurs’ focuses on zero liquid discharge through their evaporator and gas extraction design so called proprietary design. EPC contractors (Engineering, Procurement and Construction) complies the requirement of zero liquid discharge and provides the equipments and implements along with the required COD and BOD through the precommissioning and commissioning process. Operating companies and Contractors work together to make this happen. Two Entrepreneurs with the age of 50-60 years were participated from India. Ten Entrepreneurs with the age of 40-50 years were participated from India. Nine Entrepreneurs aged 30-40 years have participated from India, three entrepreneurs aged 30-40 years have participated from Australia, three entrepreneurs aged 30-40 years have participated from Singapore, two entrepreneurs aged 30-40 years have participated from Malaysia and three entrepreneurs aged 30-40 years have participated from United States of America (USA).

Researchers have observed that 65.6% of MSME entrepreneurs from India, 9.4% of MSME entrepreneurs from the Australia, 9.4% of entrepreneurs from Singapore, 6.3% entrepreneurs from Malaysia, and 9.4% of entrepreneurs from USA have participated in this study.

**Pearson Correlation:**

The correlation coefficient between zero liquid discharge and emotional intelligence is 0.91, which indicates  $(0.91^2 = 0.83)$  83.0 percentage positive relationships between EI and ZLD, The correlation coefficient between operational excellence and zero liquid discharge is 0.87, which indicates  $(0.87^2 = 0.76)$  76.0 percentage positive relationships between ROE and ZLD, and it is significant at a 1% level. The correlation coefficient between entrepreneurs decision making and zero liquid discharge is 0.1, which indicates  $(0.1^2 = 0.01)$  1.0 percentage relationships between EDM and ZLD and it is negligible, and it is significant at a 1% level.



**Fig-4. Correlation Heatmap**

The colours of each cell represents the strength and direction of the correlation, with darker colours indicating stronger correlations. Correlation is stronger between ZLD and operational excellence and emotional intelligence. Correlation is negligible between ZLD and entrepreneurs decision making strategies since entrepreneurs between EPC contractors and operating companies are fit for purpose and could achieve only 95% of effluent disposal and could not achieve zero liquid discharge due to not maintaining the required COD and BOD through ZLD process.

**Correlation Matrix**

**Table-4: Correlation Matrix**

		ROETOTA	EDMTOTA	DTFTOTA	EITOTA	ZLDTOTA
		L	L	L	L	L
ROETOTA L	Pearson' s r	—				
	df	—				
	p-value	—				
EDMTOTA L	Pearson' s r	0.453	—			
	df	30	—			
	p-value	0.009	—			
DTFTOTA L	Pearson' s r	0.452	0.379	—		
	df	30	30	—		
	p-value	0.009	0.032	—		
EITOTAL	Pearson' s r	0.844	0.226	0.433	—	
	df	30	30	30	—	
	p-value	< .001	0.214	0.013	—	
ZLDTOTA L	Pearson' s r	0.866	0.097	0.418	0.909	—
	df	30	30	30	30	—
	p-value	< .001	0.597	0.017	< .001	—



## Linear Regression

**Table-5: Model Fit Measures**

Model	R	R <sup>2</sup>	Adjusted R <sup>2</sup>
1 1	0.986	0.972	0.962

^ 1-Zero Liquid Discharge

Independent variable: Redefining operational excellence (ROE), Digital transformation (DTF), Emotional intelligence (EI), Entrepreneurur's decision making (EDM).

**Dependent variable:** Zero Liquid Discharge (ZLD)

Multiple R Value = 0.986

R Square value = 0.972

We have achieved multiple correlation coefficients (R) with 0.986, which is quite a solid and positive relationship between actual and predicted values. Hence, zero liquid discharge is quite solid and optimistic based on the impact of redefining operational excellence, emotional intelligence, digital transformation and entrepreneurs decision making. We discovered significant regression values and found that the model fit phenomenally well. The Coefficient of Determination R-square value is 0.972, i.e., the calculated SRP reveals 97.2% of the variation in operation excellence with zero liquid discharge.

## 4 Outlook & Conclusions

Researchers concluded that operational excellences with zero liquid discharge are achieved through digital transformation and emotional intelligence since these are strongly correlated. Correlation between MSME entrepreneurs decision making and zero liquid discharge are negligibly correlated since their decision making strategies to fit for purpose to achieve the performance acceptance test (PAC) and DBOOM model (Design, Build, Own, Operate and Maintain) to reduce initial CAPEX (Capital expenditure) and OPEX (Operational expenditure). Researchers observed that the model is fit pretty well and the Coefficient of Determination R-square value is 0.972, i.e., the calculated SRP reveals 97.2% of the variation in operation excellence with zero liquid discharge. However, due to the above decision making strategies, operating companies could not achieve 100% zero liquid discharge rather can only at maximum level of 97% with the required BOD and COD at plant output. MSME entrepreneurs to concentrate and deliver agreed BOD and COD by complying environmental regulations irrespective of feed and process variation and operating companies to ensure that the plant output should go to only

landfills, agriculture purpose and gardening and avoid to sending it to ocean. This way operational excellence can be achieved by each and every operating company and entrepreneur to achieve zero liquid discharge.

## 5 Recommendations, Limitations and Future research

Researchers recommended that MSME entrepreneurs focus on zero liquid discharge to comply with environmental regulations by implementing the right decision making strategies, digital transformation and emotional intelligence to achieve operational excellence based on the feed, BOD and COD to be worked and comply 100% to achieve 100% zero liquid discharge. First limitation is, government is to enforce the policies to have 100% zero liquid discharge and validate the information provided by operating companies from the start of plant implementation and during operation stage every day. The second limitation is, that operating companies need to show transparent information to comply with 100% zero liquid discharge and take care of CAPEX and OPEX during the plant implementation and plant operation. Future research to obtain more data from operating companies across the world to review zero liquid discharge to avoid discharge to ocean and verify 100% environmental regulations.

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