Contemporary Mathematics
https://ojs.wiserpub.com/index.php/CM/

Research Article

Mathematical Formulation of River Quality Index Based on Awareness of River Pollution

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Received: 10 January 2025; **Revised:** 21 March 2025; **Accepted:** 3 April 2025

Abstract: A river is an environmental commodity that is essential for the preservation and advancement of a country. Malaysia, however, has witnessed a decrease in the quality of these natural resources since the beginning of time. Therefore, awareness of activities contributing to river pollution is crucial among people, especially those around the riverside. The main purpose of this paper is to develop a mathematical formulation of river quality index based on awareness of river pollution. Thus, this paper identified human activities related to river pollution by interviewing experts and local residents near the riverside in Terengganu and Kelantan. The data collected were analyzed using a thematic analysis procedure in ATLAS.ti. Then, these findings are used to develop a mathematical formulation of a river quality index using basic composite index and human activity parameters found in this study. It is found that eleven activities contribute to negative impact of water river quality: Poor Drainage System, Livestock Farming, Illegal Dumping, Discharge of Untreated Waste, Agricultural Runoff, Attitude, Self-Awareness, Urbanization, Ship Traffic, Sand Mining Activity and Role of Government. Additionally, the weightings for each factor are evaluated and used to develop a mathematical formula based on river pollution awareness. This mathematical formulation can be used as a measurement tool for early detection of pollution sources.

Keywords: awareness, ATLAS.ti, composite index, mathematical formulation, qualitative approach

MSC: 91B60, 91C99, 91D30

1. Introduction

River is one of the most important ecological commodities essential to the preservation and advancement of the country. Due to the importance of rivers in providing groundwater, trade routes, drainage, and electricity, this becomes

DOI: https://doi.org/10.37256/cm.6520256390

vital. Consequently, rivers are essential not just for humans but also for animals and plants to survive [1, 2]. However, the historical cycle witnessed a decrease in the quality of these natural resources, and it becomes the most common problem in Malaysia [2]. According to du Plessis [3], in the 21st century, society faces many major challenges in terms of water quality. If the grand challenge is not addressed, several Sustainable Development Goals (SDGs) will be jeopardized [3]. Water quality issues are brought to the forefront of international action by the 2030 Agenda and Sustainable Development Goals (SDGs). Goal 6 specifically targets ensuring the availability and sustainable management of water and sanitation for all to address water quality challenges [4].

The application of index is used to measure the quality of water and water pollution which called Water Quality Index (WQI) has been introduced since the 1960s [5]. This index application can help to express the water quality status in a single value [6]. Most of existing water quality index nowadays focus on measuring chemical and biological parameters such as temperature, pH, Dissolved Oxygen (DO), nitrate, and Biological Oxygen Demand (BOD) [7]. The index using these parameters mostly require specialized knowledge and laboratory equipment, which can further complicate monitoring and increase costs. Regular and comprehensive sampling for chemical and biological parameters to assess river quality can be costly and time-consuming. Therefore, an alternative method should be implemented to assess river quality as a preliminary measure before conducting laboratory testing. This approach can serve as a precautionary step, allowing for early detection of potential issues and reducing the need for frequent, costly analyses.

As awareness of river pollution influences water quality indirectly, influencing individual and collective behaviour [8], it is essential to educate the public about factors that affect river quality in order to encourage them to adopt environmentally friendly practices [9]. As a result, this reduces pollutants in rivers, improving WQI parameters such as dissolved oxygen levels, turbidity, and nutrient content. In Malaysia, many rivers are still classified as polluted or moderately polluted, implying that public awareness about preserving river ecosystems and their surrounding environments is lacking [10]. Thus, this paper aims to develop a mathematical formulation of the River Quality Index (RQI) incorporating parameters relevant to public awareness of river pollution. A set of questionnaires regarding the awareness of riverside people toward human activity factors that impact to river pollution will be developed as a part of index development process. This index can be early assessment tool in measuring RQI based on people perspective and awareness towards water quality of the river, before taking water sample for laboratory testing.

2. Literature review

Water quality indices are commonly used to assess water quality in rivers, but they differ based on selection of parameters and their assigned weightage [11]. Most assessments rely on chemical and biological parameters, which require laboratory testing. However, evaluating river water quality based on human perception and awareness has received limited research, highlighting the need for alternative assessment methods.

2.1 *Application of WQI*

There are two primary methods used for water quality assessment. First, Water Quality Index (WQI) and second is National Water Quality Standard (NWQS) [12, 13]. Most of previous studies used WQI to predict the quality of water and their classification. There are four steps to a typical WQI model: (1) selecting the parameters, (2) developing sub-indices for every parameter, (3) setting the weighting values for these parameters, and (4) combining the sub-indices to arrive at the final WQI [7, 14].

Parameter selection and establishing weights steps are the challenging ones [14]. Parameter selection is the initial step of the WQI process. Among models, there were significant differences in the categories and numbers of parameters selected and their reasons for selection [7]. Water quality is usually categorized into physical, biological, and chemical parameters and for each category, there are other several parameters [14]. According to [7], there are a variety of parameters used for WQI, and they vary depending on the type of WQI modeling. The most common parameter used are temperature, pH, Suspended Solids (SS), Dissolved Oxygen (DO), turbidity, Total Dissolved Solids (TDS) and Biochemical Oxygen Demand (BOD) [7].

Besides, the number of parameters used also differ. For example, Horton Index (1960), Oregon Index (1980), Dalmatian Index (1999), Hanh Index (2010) used 8 parameters, Equivalent (EQ) Inddex (1982) and House Index (1986) used 9 parameters, SRDD Index (1970) and Almeida Index (2012) used 10 parameters, NFS Index (1965) and Dinius Index (1972) used 11 parameters. The lowest number of parameters used in WQI model is 4 and the highest number of parameters is 26 [7]. There are several types of selection process in WQI model and the most commonly used is Delphi method [7]. The other methods used to select parameters in the WQI model are key personnel interviews and expert panel judgment. These are based on monitoring data accessibility and comparing standards, environmental impact, and health impacts. Uddin et al. [15] evaluated parameter weighting using four statistical weighting methods: rank sum, Rank Reciprocal (RR), Rank Order Centroid (ROC), and Equivalent (EQ) [15].

2.2 *Human activities impacts to river pollution*

The issues of river quality negatively influenced by shifts in how humans and the climate interact. In fact, with urban development, industrial activities, and trade expansion, river quality has begun to deteriorate due to issues like erosion, sedimentation, and pollution. All these problems are rooted in human attitudes that view rivers as convenient channels to dispose of waste, filth, and remnants. According to Tun Ismail et al. [16], human activities have caused many river pollution problems in recent years. The activity of dumping rubbish and disposing of waste into drainage systems and rivers has become worse [16]. There are many factors that contribute to river pollution caused by human activities.

One of the factors contributing to the pollution of rivers is the habit of dumping rubbish into ditches and rivers [16]. Zhou et al. [17] found that river is often treated as a dump site for illegally dumped trash, untreated effluents, defecation outside, and industrial waste. Besides, the use of fertilizers in agriculture, including chemical fertilizers, promotes rapid crop growth. However, excessive or improper fertilization can cause runoff of nutrients, particularly nitrogen and phosphorus. Eventually, these nutrients enter rivers, lakes, and groundwater. Also, pesticides used to protect crops from diseases and pests contribute to water pollution [18]. The residues of pesticides in soil can be absorbed into groundwater or carried into nearby water sources via surface runoff [19].

Water pollution is also caused by the discharge of municipal and industrial wastewater, which releases contaminants directly into water bodies through pipes, drainage systems, or wastewater treatment plants [20]. Most municipal wastewater comes from households, commercial establishments, and public institutions, containing a mix of organic and inorganic pollutants including sewage, food waste, detergents, and pharmaceuticals. Industrial wastewater can contain heavy metals, toxic chemicals, solvents, oils, and grease depending on the industry in which it is manufactured [21]. Industries like textile production, mining, and chemical manufacturing can produce highly hazardous effluents. A lack of proper treatment from these wastewaters can lead to environmental degradation [22] and disease [23].

As a result, these developments have severed the connection between communities and rivers, as people can no longer use rivers for various activities such as bathing, washing, fishing, and recreation. This highlights the critical importance of raising awareness among communities, particularly those living along riverbanks, to ensure river quality preservation and improvement. Consequently, public awareness of river pollution can be a valuable parameter in measuring and assessing river quality [24]. This emphasizes the role of societal engagement in sustainable water resource management.

3. Methodology

In general, this study employed a qualitative method combined with a mathematical approach to develop a river quality index. This methodology has also been utilized in previous studies, such as study by [25] which developed an alternative tool for risk assessment in start-up business. This study implemented a qualitative technique to explore the factors that affect river quality by focusing on awareness of water pollution. It also evaluates the weightage of each factor. Qualitative research techniques such as semi structured interviews provide an in-depth examination of data collected empirically [26]. The semi-structured interview instrument was designed to provide in-depth interviews with nine experts in water management, academic scholars and residents familiar with routine activities conducted by the public near the Terengganu and Kelantan Rivers. A minimum of six to eight participants is necessary to gain a broad range of perspectives

[27]. The concept of saturation was used to determine the appropriate sample size for a qualitative study. Whenever more data does not offer new information, the saturation point is reached [28]. Both parties consented to audiotaping the interview sessions, which lasted between 30 and 45 min. Data were then analysed using the Thematic Analysis procedure in ATLAS.ti, as introduced by [26]. Thematic analysis generates themes and subthemes that reveal human activities that negatively impact river quality. Besides, Code Document Table (CDT) from ATLAS.ti, gives the weightage for each factor which is useful in developing the river quality index later. The results obtained will be used to develop a new mathematical formulation of the River Quality Index (RQI) along with a basic formulation of a composite index. It has also been used to formulate risk indexes in previous studies by [29, 30].

$$\bar{I} = \frac{\sum (I_i W_i)}{\sum W_n} \tag{1}$$

where

$i = 1, 2, 3, 4, ..., n$;

$n = 1, 2, 3, 4, ..., n$;

I = index number for every human activity factor based on items in questionnaires;

W = weightage of each human activity factors.

The summarization of the methodology applied for the process as follows:

Step 1: Selection of parameter by Thematic Analysis procedure.

Step 2: Evaluation of the weightage according to result of CDT table from ATLAS.ti.

Step 3: Construction of a new mathematical formulation of RQI based on awareness of river pollution.

Step 4: Development of key indicator for RQI based on awareness of river pollution.

4. Findings

The main purpose of this paper is to develop a new mathematical formulation of the River Quality Index (RQI) based on awareness of the water population. This study revealed the human activity factors that contribute to river pollution, which act as parameters used for the RQI. Then, these parameters were weighted accordingly and later used to construct the new RQI. A key indicator for RQI based on awareness of water pollution was developed as a final development.

4.1 *Selection of parameter*

The selected parameter for the development of RQI in this study is the factors that affect the water quality of the river based on human activities. These factors are selected from thematic analysis in ATLAS.ti software. Following the identification of the associations between themes and subthemes using a network diagram, Figure 1 visualizes the human activities that impact the quality of the river.

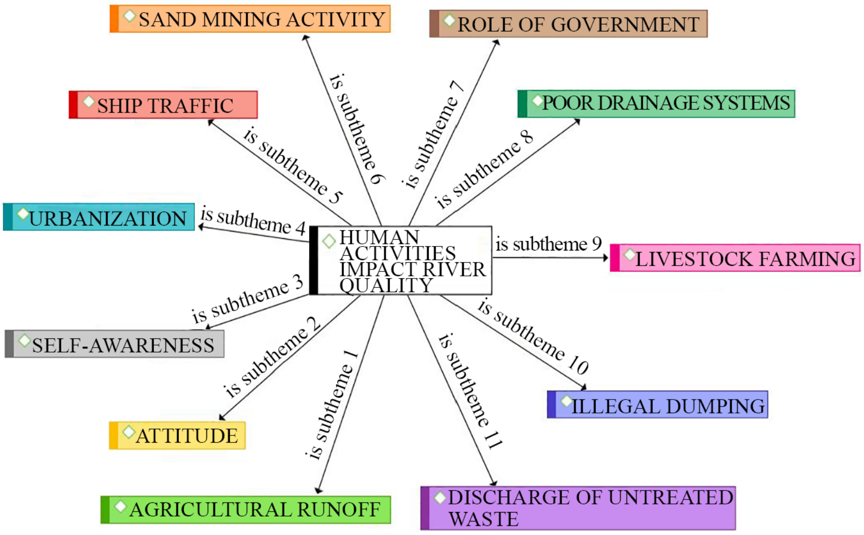

Figure 1. Human activities impact river quality
Source: Authors' elaboration (developed using ATLAS.ti)

The underlying theme of this study is human activities impacting river quality, while the subthemes are Poor Drainage System, Livestock Farming, Illegal Dumping, Discharge of Untreated Waste, Agricultural Runoff, Attitude, Self-Awareness, Urbanization, Ship Traffic, Sand Mining Activity, and Role of Government. As a result, 11 parameters were selected for the development of RQI in this study.

A Sankey Diagram, developed by ATLAS.ti software, illustrates the various human activity factors identified by all participants. In this study, the nine case studies correspond to nine experts who participated in the interviews, providing valuable insights into the discussed factors. In Figure 2, the Sankey Diagram shows that Urbanization conquered the largest area, while Agricultural Runoff conquered the smallest. This means urbanization has the largest impact on river water quality, while agricultural runoff has the smallest impact.

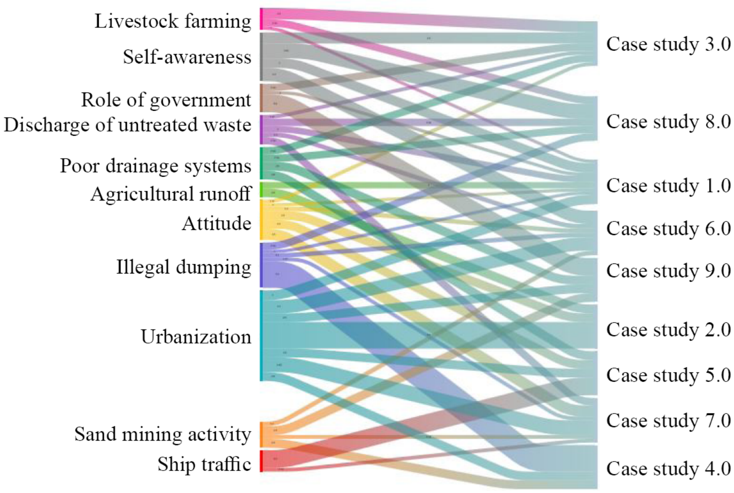

Figure 2. Sankey diagram
Source: Authors' elaboration (developed using ATLAS.ti)

4.2 *Evaluation of weightage for each human activity parameters*

The result of CDT Analysis from ATLAS.ti software revealed the ranking of each human activity factors that impact to water quality river. The ranking and weightage in this study are given based on their relative frequency. The first ranking is the factor with the highest frequency, while the last ranking is the factor with the lowest frequency. This ranking is a crucial step in risk assessment and serves as a guide to show the relative importance of each factor [31]. The first ranking is given the greatest weighting in this study, while the last ranking is given the lowest weight. Because composite index formulas are used, this weighting part is crucial when creating a risk index [31, 32]. The summarization of the factors, ranking, relative frequency and weightage are shown in Table 1 below.

Table 1. Ranking and relative frequency for human activity parameters based on CDT analysis

Ranking	Human activity parameters	Relative frequency	Weightage
1	Urbanization	28.67	11
2	Self-Awareness	15.37	10
3	Illegal dumping	14.30	9
4	Attitude	12.67	8
5	Poor drainage system	10.27	7
6	Discharge of untreated waste	9.23	6
7	Role of government	8.93	5
8	Sand mining activity	8.17	4
9	Livestock farming	6.83	3
10	Ship traffic	6.77	2
11	Agricultural runoff	4.80	1

Source: Authors' elaboration

The study evaluated 11 human activity factors that impact river water quality, so 11 weighted factors are most significant, while 1 weighted factor is least significant. The result shows that urbanization has the largest relative frequency of 28.67. Therefore, this factor is assigned the highest weight of 11. Self-awareness is given a second highest weight of 10. This is followed by illegal dumping and attitude, with 9 and 8 weights, respectively. Runoff from agricultural land has the lowest relative frequency at 4.80, thus it is given 1 weight.

4.3 *Construction of RQI based on human activity factors*

An important component of this study is the development of a questionnaire to develop the mathematical formulation of RQI. This is because each factor's sub-index will be calculated according to the number of items in the questionnaire. Questionnaires are designed to determine whether riverside residents are aware of the factors that contribute to the degradation of river water quality. The questionnaires were answered using a 10-point Likert scale. The summary of the questionnaire and the sub-index according to each factor are compiled in Table 2.

Table 2. Summary of questionnaire on awareness toward human activity factors with weightage and formulation sub-index

Human activity factors	Items	Weightage, W	Formulation of sub-index
Urbanization (UR)	UR1, UR2, UR3	$W_{UR} = 11$	$\sum_{i=1}^{3} A_i$
Self-Awareness (SA)	SA1, SA2, SA3, SA4, SA5	$W_{SA} = 10$	$\sum_{i=1}^{5} B_i$
Illegal Dumping (ID)	ID1, ID2, ID3, ID4	$W_{ID} = 9$	$\sum_{i=1}^{4} C_i$
Attitude (AT)	AT1, AT2, AT3, AT4, AT5	$W_{AT} = 8$	$\sum_{i=1}^{5} D_i$
Poor Drainage System (DS)	DS1, DS2, DS3	$W_{DS} = 7$	$\sum_{i=1}^{3} E_i$
Discharge of Untreated Waste (DW)	DW1, DW2, DW3, DW4, DW5	$W_{DW} = 6$	$\sum_{i=1}^{5} F_i$
Role of Government (RG)	RG1, RG2, RG3, RG4	$W_{RG} = 5$	$\sum_{i=1}^{4} G_i$
Sand Mining Activity (SM)	SM1, SM2	$W_{SM} = 4$	$\sum_{i=1}^{2} H_i$
Livestock Farming (LF)	LF1, LF2, LF3	$W_{LF} = 3$	$\sum_{i=1}^{3} I_i$
Ship Traffic (ST)	ST1, ST2	$W_{ST} = 2$	$\sum_{i=1}^{2} J_i$
Agricultural Runoff (AR)	AR1, AR2, AR3	$W_{AR} = 1$	$\sum_{i=1}^{3} K_i$

The weightage and sub-index for each factor are then substituted into Equation (1) after the sub-indices are constructed. The Equation (2) below illustrates the mathematical formulation of RQI based on awareness of river quality:

$$
\begin{aligned}
\bar{I} &= \frac{\sum (I_i W_i)}{\sum W_n} \\
&= \frac{\left(W_{UR}\sum_{i=1}^{3} A_i\right) + \left(W_{SA}\sum_{i=1}^{5} B_i\right) + \left(W_{ID}\sum_{i=1}^{4} C_i\right) + \left(W_{AT}\sum_{i=1}^{5} D_i\right) + \left(W_{DS}\sum_{i=1}^{3} E_i\right) + \left(W_{DW}\sum_{i=1}^{5} F_i\right) + \left(W_{RG}\sum_{i=1}^{4} G_i\right) + \left(W_{SM}\sum_{i=1}^{2} H_i\right) + \left(W_{LF}\sum_{i=1}^{3} I_i\right) + \left(W_{ST}\sum_{i=1}^{2} J_i\right) + \left(W_{AR}\sum_{i=1}^{3} K_i\right)}{W_{UR} + W_{SA} + W_{ID} + W_{AT} + W_{DS} + W_{DW} + W_{RG} + W_{SM} + W_{LF} + W_{ST} + W_{AR}} \\
&= \frac{\left(11\sum_{i=1}^{3} A_i\right) + \left(10\sum_{i=1}^{5} B_i\right) + \left(9\sum_{i=1}^{4} C_i\right) + \left(8\sum_{i=1}^{5} D_i\right) + \left(7\sum_{i=1}^{3} E_i\right) + \left(6\sum_{i=1}^{5} F_i\right) + \left(5\sum_{i=1}^{4} G_i\right) + \left(4\sum_{i=1}^{2} H_i\right) + \left(3\sum_{i=1}^{3} I_i\right) + \left(2\sum_{i=1}^{2} J_i\right) + \left(1\sum_{i=1}^{3} K_i\right)}{11+10+9+8+7+6+5+4+3+2+1} \\
&= \frac{\left(11\sum_{i=1}^{3} A_i\right) + \left(10\sum_{i=1}^{5} B_i\right) + \left(9\sum_{i=1}^{4} C_i\right) + \left(8\sum_{i=1}^{5} D_i\right) + \left(7\sum_{i=1}^{3} E_i\right) + \left(6\sum_{i=1}^{5} F_i\right) + \left(5\sum_{i=1}^{4} G_i\right) + \left(4\sum_{i=1}^{2} H_i\right) + \left(3\sum_{i=1}^{3} I_i\right) + \left(2\sum_{i=1}^{2} J_i\right) + \left(1\sum_{i=1}^{3} K_i\right)}{66}
\end{aligned}
\tag{2}
$$

where A_i, $B_{i, \ldots\ldots,}$ K_i represent the response for every item in the questionnaire.

4.4 *Development of key indicator of RQI based on awareness of human activity factors*

To establish the key indicator, the study utilized three layers commonly employed in most assessment tools. The awareness-based RQI key indicator reflects river water quality at a high, medium, or low level. To determine these levels, respondents are assumed to answer all questionnaire items with a maximum score of 10 for a high level and a minimum score of 1 for a low level. Then, the score is substituted into the formulation of awareness-based RQI. The key indicator calculation is demonstrated as shown below.

Maximum Range:

$$\begin{aligned}
&= \frac{\begin{array}{l} 11(10+10+10)+10(10+10+10+10+10)+9(10+10+10+10)+8(10+10+10+10+10) \\ +7(10+10+10)+6(10+10+10+10+10)+5(10+10+10+10)+4(10+10)+3(10+10+10) \\ +2(10+10)+1(10+10+10) \end{array}}{66} \\
&= \frac{11(30)+10(50)+9(40)+8(50)+7(30)+6(50)+5(40)+4(20)+3(30)+2(20)+1(30)}{66} \\
&= \frac{330+500+360+400+210+300+200+80+90+40+30}{66} \\
&= 38.48
\end{aligned} \tag{3}$$

Minimum Range:

$$\begin{aligned}
&= \frac{\begin{array}{l} 11(1+1+1)+10(1+1+1+1+1)+9(1+1+1+1)+8(1+1+1+1+1)+7(1+1+1) \\ +6(1+1+1+1+1)+5(1+1+1+1)+4(1+1)+3(1+1+1)+2(1+1)+1(1+1+1) \end{array}}{66} \\
&= \frac{11(3)+10(5)+9(4)+8(5)+7(3)+6(5)+5(4)+4(2)+3(3)+2(2)+1(3)}{66} \\
&= \frac{254}{66} \\
&= 3.85
\end{aligned} \tag{4}$$

Range of differences:
= Maximum Range $-$ Minimum Range $= 38.48 - 3.85 = 34.63$.
Range of one layer:
= Range of difference$/3 = 34.63/3 = 11.54$.
Low Range Minimum $= 3.85$.

Low Range Maximum = 3.85 + 11.54 = 15.39.

High Range Maximum = 38.48.

High Range Minimum = 38.48 − 11.54 = 26.94.

As shown in Figure 3, the key indicators for the River Quality Index range are constructed.

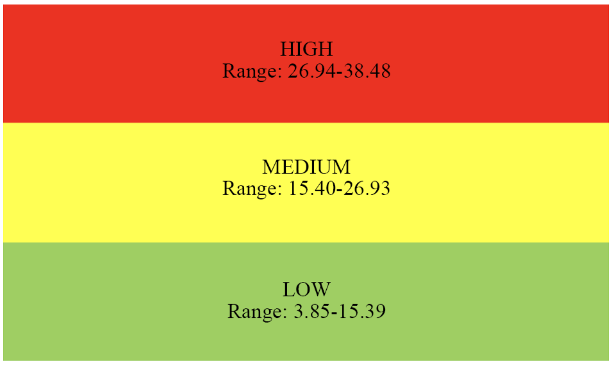

Figure 3. Key indicator for river quality index based on awareness of river pollution
Source: Authors' elaboration

5. Discussion

In this study, human activities are emphasized as having a considerable influence on river quality degradation and river pollution. About 11 human activity factors were identified as crucial to the development of the River Quality Index (RQI), which are: poor drainage system, livestock farming, illegal dumping, discharge of untreated waste, agricultural runoff, attitude, self-awareness, urbanization, ship traffic, sand mining activity, and the role of government. Some of the human activity factors found in this study are in line with the study by [17, 33]. Zhou et al. [17] found that human activity factors impacting river pollution come from agricultural, domestic, and industrial activities. Another researcher believed that pollution in the river is due to illegal mining, agriculture along the riverbank, and untreated waste discharge [33].

This study emphasizes the importance of appropriate drainage systems in houses, residences, factories, and industrial areas. Well-designed drainage infrastructure prevents water pollution and ensures wastewater disposal is safe. When a drainage system is inadequate, untreated domestic and industrial wastewater is released directly into rivers, decreasing the water quality of the river and resulting river pollution. The participant in this study noted that some waste from the sinks in some of the houses in her area goes directly into the river. Some participants also mentioned that some people throw garbage and waste into rivers because they are too lazy to throw it in garbage bins due to the distance. This aligns with the findings of [34], who emphasized that human behavior significantly influences river pollution through their interactions and attitudes toward the river.

There are also issues associated with the disposal of industrial waste into rivers, as some factories dump waste directly into water sources. It is often driven by the desire to cut costs and simplify processes without implementing a proper waste management system. The issue arises because of an absence of awareness and environmental responsibility in certain industries, without realizing the long-term consequences. Previous researcher reported that it is common for untreated sewage to be drained illegally in urban, rural, and industrial environments [35]. In this regard, the government plays a crucial role in establishing and enforcing drainage policies, regulations, and standards. Residential and industrial developments are required to meet environmental standards, and wastewater must be treated before it is discharged into rivers.

As a result of irresponsible behaviour, untreated waste and feces end up in rivers, along with raw sewage, industrial waste, and trash dumped there [17]. So, it is important to educate the people and increase the awareness among them especially people who live in riverside. This is because, if they are aware on effect toward water quality river which come from human activity factors, and be responsible towards quality of the river, the river can maintain and increase their quality. In addition, multiple factors influence public perception of issues, including public engagement, which requires extensive knowledge and awareness of that area [9]. As a result, public perception of river pollution plays a huge role in predicting river water quality. River water quality can be evaluated by examining how riverside residents feel about human activity factors in their area and the importance of maintaining river cleanliness. If riverside residents are aware of human activities that negatively impact river water quality, they can take action accordingly. As a result, this index can be used as an early detection tool for river pollution.

This study also discovered the weightage for each human activity factors based on relative frequency in Code Document Table (CDT) obtained from ATLAS.ti software. Among these human activity factors, the most significant is urbanization. According to [33, 36], pollution levels in river water are increasing as urbanization and industrialization increase along riverside areas. Urbanization results from residential, industrial, and agricultural demand. Consequently, other human activity factors, such as poor drainage and ship traffic, occur. Some participants in the study brought up these concerns. The increased number of people at the riverside due to urbanization also give impact negatively on river quality. Urbanization may also result in increased ship traffic, which can affect river quality water. Two participants in this study expressed this opinion. As the fishing industry has developed rapidly, fishing boats have become much larger and more numerous. Despite its positive effects, this growth is also associated with negative consequences, such as boat oil spills. Agricultural runoff is the least weighted since only two participants mentioned it. This is because there is not much agricultural activity in this study area, so this factor is not a major problem as not all residents are involved in agriculture. However, this study still considers this factor so that the development of RQI is applicable to the general study area.

Mathematical techniques are effectively integrated in this paper to develop measurement tools that are efficient and user-friendly. By integrating mathematical approaches, complex data analysis can be simplified, and key variables can be measured more efficiently [37–39]. This study aims to develop a mathematical formulation of the River Quality Index (RQI) based on public awareness of river pollution. Before laboratory testing, this mathematical index is an early indicator of river quality. This index provides communities, environmentalists, and policymakers with a tool to evaluate river health and identify areas for improvement. Indices are widely used, especially as measurement tools. For example, they are used as measurement tools for start-up businesses index [29]. Additionally, policymakers can prioritize the most critical parameters using this index formulation that evaluates the level of factors that affect river quality. It provides a structured assessment of river quality, enabling policymakers to address pollution and ensure sustainable river management. However, according to previous study, additional study must be conducted to confirm the applicability and utility of this recently created index. A previous study by [40] for instance, examined user acceptance after developing a modified Auto Takaful model.

6. Conclusion & recommendations

In conclusion, developing a River Quality Index (RQI) provides a structured and practical framework for assessing and managing river water quality. In addition, it serves as an early protection measure against river pollution. Incorporating human activities and pollution sources, the RQI offers a comprehensive framework for identifying factors that affect river water quality. Using this calculation, communities and authorities can identify pollution threats early, allowing them to mitigate pollution risks before comprehensive lab testing. By utilizing this index, communities and policymakers can identify strategies to mitigate pollution and enhance sustainability based on human activity factors. Furthermore, the RQI enhances public awareness and participation, encouraging proactive conservation efforts. The index acts as a guideline for decision-making processes, ensuring rivers remain essential resources for ecological balance, economic activity, and community well-being. Ultimately, the RQI contributes to long-term river conservation and sustainable water management. It is suggested to develop a web-based RQI system, so it can be easier accessed. Also, it is recommended that the selection parameters and their weightage be validated by comparing the results using other methods. These methods include the Fuzzy Delphi Method (FDM) or other statistical methods. Furthermore, governments should provide enough funding and resources for public drainage infrastructure. The government can raise public awareness through education campaigns, encouraging communities and industries to implement efficient management practices. By implementing comprehensive policies and fostering stakeholder collaboration, the government can ensure effective drainage systems, safeguard water quality, and reduce pollution risks in rivers and other natural resources.

Acknowledgement

This research was supported by the Dana penyelidikan Universiti through the Internal University Grant (UniSZA/2023/DPU 2.0/18-RD071).

Conflict of interest

There is no conflict of interest for this study.

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