Fuzzy Games for Simulation of Uncertainty in Decision Making by Syrian Wastewater Treatment Plant Projects

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□ ABSTRACT □

Wastewater treatment is one of the important elements for achieving sustainable development due to its close association with its economic, social and environmental concepts. This are achieved through the selection of the optimal treatment system, but most treatment systems in Syria did not succeed because these systems were transferred from other countries without testing the extent of their suitability to them. In addition, that studies conducted on treatment systems were based on other conditions and data, which makes it necessary to re-adjust them to suit local conditions.

It is shown that this methodical instrumentation allows adequate formulation of the real situation. If a strategy (e.g., the choice of treatment plant type) is to be optimal, it must satisfy the strategy characterizing attributes of the solution's performance (parameters, features, etc.). The score evaluation is not subordinate to the crisp logic, but is a fuzzy term.

To understand this relation more closely, the influence parameters on the system that characterize the quality attributes can be divided into two main groups, internal and external parameters of the system. Between these two groups, the conflict can be handled as a game. Two peculiarities can be mentioned here: 1- The decision is strategic, 2- The information content is low, with information gathering increasing as the decision.

Keywords: Fuzzy games- Simulation- Decision making.

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ألعاب استراتيجية ضبابية لمحاكاة عدم التأكد باتخاذ القرار في مشاريع محطات معالجة مياه الصرف الصحي السورية

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☐ ملخّص ☐

تعتبر معالجة مياه الصرف الصحي أحد العناصر المهمة لتحقيق التنمية المستدامة بسبب ارتباطها الوثيق بمفاهيمها الاقتصادية والاجتماعية والبيئية. ويتحقق ذلك من خلال اختيار نظام المعالجة الأمثل، لكن معظم أنظمة المعالجة في سوريا لم تنجح لأن هذه الأنظمة تم نقلها من دول أخرى دون اختبار مدى ملاءمتها لها. بالإضافة إلى أن الدراسات التي أجريت على أنظمة المعالجة استندت إلى شروط وبيانات أخرى، مما يجعل من الضروري إعادة ضبطها لتلائم الظروف المحلية.

الأدوات المنهجية المستخدمة في هذا البحث تسمح بصياغة مناسبة للوضع الحقيقي. إذا كانت الاستراتيجية (على سبيل المثال، اختيار نوع محطة المعالجة) هي الأمثل، فيجب أن تفي بالاستراتيجية التي تميز سمات أداء الحل (البارامترات، الميزات، إلخ). تقييم النتيجة ليس خاضعًا للمنطق الكلاسيكي إنما للمنطق الضبابي.

لفهم هذه العلاقة عن كثب، يمكن تقسيم معاملات التأثير على النظام التي تميز سمات الجودة إلى مجموعتين رئيسيتين، البارامترات الداخلية والخارجية للنظام. بين هاتين المجموعتين، يمكن التعامل مع الحالة كلعبة استراتيجية بالمفهوم الرياضي. نذكر خاصيتين هنا: 1- القرار استراتيجي، 2- محتوى المعلومات منخفض، مع تزايد جمع المعلومات كلما اتخذ القرار.

الكلمات المفتاحية: العاب استراتيجية- محاكاة – اتخاذ القرار.

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Introduction:

The project of establishing a treatment plant is one of the projects that need great accuracy due to the sensitivity of the plant's work, its large cost and its multiple environmental, health, social and tourism impacts. Therefore, the risk factors affecting the choice of the system should be taken into consideration. The choice and classification of alternatives to be evaluated according to multi criteria is not an easy one. In these issues, there is no alternative can be considered as the best for all criteria, for example, the best-quality alternative is often the most expensive. In order to evaluate or compare a range of alternatives from a well-defined point of view, this evaluation process must take into account all the characteristics of the considered perspective. The government often needs to make decisions about large investments under uncertain circumstances. Therefore, to model these issues, expert opinions are sometimes required to assess the possible impacts. The performance of alternatives, in such cases and where numerical values are not available is replaced by so-called qualitative data. All decisions on the environment are usually multi-criteria (quantitative and qualitative). Multi-criteria analysis in environmental management has been shown to be an effective tool for achieving the assimilation, transparency, acceptance and strength of resolution, and the aim of studying the issue as a multi-criteria issue It is an attempt to make an optimal realistic decision that is preferable in other words, to find a compromise, this solution depends largely on the character of the decision-maker, the circumstances surrounding the decision support process, the method of modelling the issue, and the methodology used as well.
The issue of deciding to choose an optimal system for wastewater treatment requires an evaluation of treatment systems according to the set of criteria affecting this decision. as this evaluation process is subject to the evaluation of experts in this field because of the nature of the criteria, most of which are not measurable or the data necessary to evaluate it is not available or, therefore, approximate values can be relied upon to evaluate these criteria, which are obtained from experience, in addition to the above, not all criteria are of the same importance and therefore to complete the evaluation process, it is necessary to determine the importance of these standards in relation to each other, The evaluation process in the matter of decision-making to choose a wastewater treatment system is subject to the evaluation of experts according to the degrees of their experience.
Finely we need solutions in which the decision maker can express all the factors that influence the decision issue such as experience, intuition or Believes, and despite the increasing uncertainty, uncertainty and uncertainty in the data, the more information we have the more we were able to better understand alternatives (solutions).

Research Importance and Objective:

Research Objective:

This search aim to:
1. Evaluation of multiple alternatives to wastewater treatment systems.
2. Developing a methodology for solving the problem of decision-making - multiple ecosystem, decision-making support - support for environmental decision system under uncertainty.

Research Importance:

In Syria, most areas suffer from environmental, health, economic and social impacts resulting from contaminated and untreated wastewater, as wastewater is discharged to the sea or to land and thus to ground and surface water leading to the spread of pollution and disease. Achieving the levels of treatment specified by the health and environment systems in an economical manner while achieving the requirements of preserving the environment and public health and thus raising the level of social life, in addition to achieving the possibility of reusing the treated water and other products for treatment. The amount of pollutants reaching the seawater is a source of threat to our natural environment and our lives. Therefore, the conservation of seawater from these pollutants has become a very urgent necessity through a comprehensive management process of polluted water, especially after the large population growth, which is one of the reasons for the increase of pollutants reaching the sea. Either through direct discharge to nearby areas or through rivers, waterways that reach the sea in addition to the harm caused when its water reaches the groundwater or when using this water for agricultural purposes where these pollutants reach the in which we eat and the impact on the environmental and economic system.

Research Problem:

The treatment of contaminated water is undoubtedly costly. However, untreated causes significant losses that extend to long decades, where improper treatment affects the economy, culture and health. The cost of poor management of pollutants is very high. The high cost, need for technological development, lack of resources and responsible organizations are the root causes of delays or slow progress in effective work in this area in developing countries [1], and therefore wastewater treatment requires an integrated management process involving all environmental, economic, social and political actors. The choice of an optimal wastewater treatment system is an important part of the integrated management process.

Four basic concepts related to the issue of urban wastewater management in coastal areas can be identified[2]:

1. Social requirements for sanitation.
2. Conflicting the interests of users, for example, between water supply and drainage.
3. Impact of contaminated water discharge on sensitive ecosystems.
4. Requirements of development and planning such as plans for the development of agriculture, tourism infrastructure and integrated coastal zone management processes.

The choice of treatment technology is an important step in the process of integrated contaminated water management. The performance, reliability and management requirements of the selected technology (planning, design, construction, operation and maintenance capacity, availability of trained personnel), and investment, operation and maintenance costs are important considerations [2]. As a result, determining the optimal system for wastewater treatment plants is a complex issue and requires participation. And the consensus of different parties (social, economic, environmental) to find the best solution [2].

The coastal area is considered the area of life and environment in Syria, where most of the agricultural lands are located in this region, so the land is of great value in terms of maintaining the continuity of agriculture and thus vegetation as a key element in the preservation of the environment. The national economy in Syria depends heavily on agricultural products. The tourism reality in the coastal area and not affect the quality of this national source. Water resources are used as a source to provide drinking water and water required for agriculture, it must focus on the effectiveness of the treatment of contaminated water that flows into water resources such as rivers and liquids and then used in agriculture or pour into the sea. Al Kleaah – Al Dilbeh small town is in Tartous Governorate, with a population of 35000 inhabitants, and it is 30km away from the city of Tartous.

Methodology:

The selection of an optimal wastewater treatment system in the small town of Al Kleaah – Al Dilbeh can be formulated as follows: An optimal wastewater treatment system is to be selected for a small town of 35.000 inhabitants, where eight wastewater treatment systems can be discussed, all of which achieve at least 90% efficiency in removing BOD5.

The targets and the criteria are completely uncertain or foggy. We cannot say that we need a water treatment system at a low cost, and if a system does not meet this cost it is unacceptable, but this does not mean that there is no specific cost requirement from some of these criteria are dependent on the characteristics of each system and may be called system criteria:

- Required area of land.
- Internal environmental effects (spread of insects - resulting noise).
- Cost (basic - cost of operation and maintenance - cost of installing protectors).

Some of these criteria are imposed due to external circumstances and data:

- Risk factors (power failure, administrative failure, design errors, implementation errors, and operation and maintenance errors, flexibility).
- Investment and operation (difficulty of operation - difficulty of maintenance - experience gained from previous systems).
- Negative effects (spray spread - smells spread).
- Resources (difficulty of implementation - availability of equipment).

In addition, the performance of systems with respect to these criteria cannot be expressed in terms of a fixed number or value due to the absence of a specific value. Nevertheless, a fuzzy value, and each value that meets the desired objective (e.g., ideal cost (minimum) or smaller land area) to a certain degree (organic degree) represents the degree to which we achieve the optimization we seek, which represents the amount of confidence in achieving this value to the desired goal, which is the principle upon fuzzy logic[3]. The evaluation process is based on expert opinions. For each of these criteria, it is noticeable that the performance value of the same alternative varies for the same criterion among experts due to varying degrees of experience and background knowledge, and this leads us to the fact that the value of performance is not specified or uncertain (not known accurately).

After collecting information on the evaluation of alternatives from three experts, we obtained matrices whose lines represent the study alternatives and their parameters columns. A classification of the criteria was carried out in two groups (system criteria and external conditions criteria), thus obtaining two types of matrices: systems parameters matrix and external conditions criteria matrix. The assessment was conducted in two different ways by experts: linguistic and numerical data (in the form of ratios).

So there are three types of data: - Measured data. - Estimated ratios. - Linguistic expressions[4].

The linguistic expressions used are fuzzy sets that cannot be represented by a single value but by a set of values, and the inability to set clear boundaries for these fuzzy sets allows a value (or set of values) to belong to more than one fuzzy set with different degrees of membership. They may be equal in some special cases, so each linguistic assessment represents a fuzzy set, i.e., a linguistic expression is categorized into nested fuzzy sets, intersecting each other for two adjacent sets, where the set of values belonging to each set or linguistic expression and continued affiliation values to these sets, and the continued use of organic Triangular in fuzzy sets representing linguistic expressions [3].

The percentages used in the assessment process include uncertainty for two reasons:

1. The performance of the alternatives against the criteria was assessed by the experts.
2. The degree of assessment varies among experts and therefore this value is uncertain.

Because there is a difference in the opinions of experts, the probabilistic function of each performance value should be studied. This means taking the opinions of a sample of experts. Because of the lack of a sufficient sample of experts, the value will be represented by a fuzzy value.

The system criteria matrix:

We have a set of measured data, the same one that expresses the parameter (square meter of area and Syrian pounds per cost), and a set of data estimated by experts for example). Alternatives achieve objectives to varying degrees, which is expressed in terms of the membership determined by the membership dependencies of each objective (or a system criteria). For example, an alternative performance is assessed against a given criterion to the extent that the achievement of this alternative represents the studied target. Express it through these criteria. The internal strength of the alternative is assessed by a total value representing the performance evaluation of the alternative relative to the system criteria.

Also in the matrix of external conditions, criteria alternatives achieve the objectives of these criteria in different degrees determined by the membership of each objective (or external criterion). Where these degrees represent the resistance of alternatives to the influence of external factors, i.e., an alternative performance is evaluated against a criterion the degree to which this alternative is achieved represents the measured objective expressed in this criterion[5].

To choose the optimal solution, the decision maker will test each of the alternatives that determine the degree of internal strength, that is, test the impact of each external factor on each of these alternatives, and each time determining the degree of resistance of the alternative to the impact of the external factor, the best alternative is alternative to the best worst case of external conditions for each of the alternatives.

The methodology included the following steps:

Step 1: Determine the fuzzy judgment matrix:

This step includes:

- Shaping the issue as a multi-criteria decision and building its own tree structure.
- Determine the performance of alternatives for different criteria.
- Convert previous values to Fuzzification.

Formation of the hierarchical structure

The multi-criteria issue was defined and represented in the form of a hierarchical structure according to the principle of the method of AHP of Saaty [6], in order to clarify and simplify the issue and make it more transparent. Scientific and analytical methods. The main objective is placed at the highest level of the hierarchical structure, while the basic criteria are placed at the second level, the sub-criteria at the third level, and the sub-sub-criteria at the fourth level, where alternatives are evaluated against the criteria at the last level. The main objective in choosing an optimal wastewater treatment system is to achieve sustainable development, which is the highest level in the hierarchical structure:

Level 1: Sustainable Development. These criteria are divided into two types of criteria:

Level 2: - Systems criteria.

- External conditions criteria.

The criteria for external conditions include - Risk factors. - Investment and operation. - Negative effects. - Resources.

Level 3: criteria include:
- The space required. - Internal environmental impacts. - The Cost

Level 4: Each of the criteria in the third level includes a set of sub-criteria as follows:
Environmental impacts include - The spread of insects. - The resulting commotion.

Cost includes: - Invest cost. - Operation and maintenance costs. -- Cost of sludge preparation.

Risk factors include: - Blackouts. - Administrative failure. - Design errors. - Execution errors. - Operation and maintenance errors. - Flexibility.

Investment and operation includes: - Difficulty operating. - Difficult maintenance. - Experience gained from previous systems. - Negative effects include :(Spread the spray. - Smells spread).

Bottom-up assessment will be used where each alternative is evaluated according to the sub-criteria first, then the sub-criteria evaluations of a key criterion are combined and so on to the primary objective assessment for each of the alternatives.

Criteria assessment:
Here the criteria are classified into two main groups according to their nature:

- Evaluate the tangible criteria
These are the parameters whose values can be determined from existing data (invest cost - operation and maintenance cost - required space - similar system).
- Invest cost, operation, and maintenance cost: evaluated in Syrian pounds per person (SP / person).
- Required area: It was evaluated with the required area in square meters per person (m^2 / person).
- The existence of a similar system: was evaluated by the number of systems implemented in Syria from each system (unit).

- Evaluate the intangible criteria:
It is difficult to measure these criteria and will therefore be evaluated by experts using linguistic expressions and relative metrics that reflect the opinion of each expert.
- The evaluation of these criteria by the first expert using linguistic expressions (very high - high - medium - few - very little)
- The evaluation of these criteria was done by the second and third experts using percentages (0-100).

The strategic game according to the concept of fuzzy logic:
The game that will be played between players can be represented as follows[7]:

$\Gamma\mu = \{(S_{1i}, \mu_{1i}); (S_{2j}, \mu_{ij}); (a_{ij}, \mu')\}$

Whereas:

S_{1i}-: First player strategies (1) (approval maker): (i = 1, ……, m), where m is the number of strategies.

μ_{1i} - the membership tiers accompanying the decision-maker strategies (player (1)) as they are determined

Each strategy has a game (choosing an alternative according to a standard) that falls under the control of the decision-maker, according to the goal that the decision-maker sets from each of the criteria controlled.

S_{2j} -: second player strategies (2) (nature) :(j = 1, ……, n), where n is the number of strategies.

- μ_{ij} (i = 1… m; j = 1… n)

The degrees of membership accompanying the strategies of the second player (choosing an alternative according to some criterion) that are under the control of nature, and it determines the degree to which each alternative achieves the goal in order for each of the criteria influenced by nature.

a_{ij}- (i = 1… m; j = 1, ..., n) The game score for each stage:

μ : The degree of membership that determines confidence in choosing an alternate, according to the strategies of each player.

This method can be illustrated by the following steps:

<u>The first step:</u>

In this step, the fuzzy sets are the decision-making criteria Cl (l = 1,… L) which we can call internal factors (Internal Parameters), which are L and these criteria are part of the criteria that evaluate the set of alternatives and can be controlled by Decision-maker, as the performance of each of the alternatives i = 1, ... m) (S1i) with respect to each of the criteria kl achieves this criterion with a certain degree, i.e. the degree of membership µil is determined through the membership dependent, according to the value of performance, and the evaluation µ1i for each of the alternatives in relation to all internal criteria is by aggregating the membership scores for this alternative using lap law lace criterion) which depends on achieving compensation and balance between the different values of membership degrees and this is justified given that these criteria are under the control of the decision maker.

$$\frac{1}{L}\sum_{l=1}^{L}\mu_{li} \quad \mu_{il} = \qquad \textit{(Laplace criterion)}$$

Whereas, L is the number of Internal Parameters, and this relationship applies for each of the alternatives (i).

	k_1	k_2	…	k_l	…	k_L	μ_{1i}
s_{11}	μ_{11}	μ_{12}	…	μ_{1l}	…	μ_{1L}	μ_{11}
s_{12}	μ_{21}	μ_{22}	…	μ_{2l}	…	μ_{2L}	μ_{12}
….	…	…	…	…	…	…	…
s_{1i}	μ_{i1}	μ_{i2}	…	μ_{il}	…	μ_{iL}	μ_{1i}
…	…	…	…	…	…	…	…
s_{1m}	μ_{m1}	μ_{m2}	…	μ_{ml}	…	μ_{mL}	μ_{1m}

<u>The second step:</u>

In this step, the fuzzy sets are the criteria outside the control of the decision maker kj (j = 1, ……. n) and their number, n, which are subject to the control of nature and can be called external factors (External Parameters), and in the same way we give μ_{ij} membership degrees for each of the alternatives i = 1, ... m)) S_{1i} according to the degree to which each of the external criteria is achieved through the membership function, and the results are arranged as a matrix as follows:

	s_{21}	s_{22}	…	s_{2j}	…	s_{2n}
s_{11}	μ_{11}	μ_{12}	…	μ_{1j}	…	μ_{1n}
s_{12}	μ_{21}	μ_{22}	…	μ_{2j}	…	μ_{2n}
….	…	…	…	…	…	…

s_{1i}	μ_{i1}	μ_{i2}	…	μ_{ij}	…	μ_{in}
…	…	…	…	…	…	…
s_{1m}	μ_{m1}	μ_{m2}	…	μ_{mj}	…	μ_{mn}

The third step:

In this step, we obtain the final matrix by aggregating the results of the previous two matrices, using the concept of (min-max) where:

$$\mu'_{ij} = \min(\mu_{il}, \mu_{ij})$$

$$\mu''_{ij} = \max_{\substack{i=1...m \\ j=1...n}} (\mu'_{ij})$$

	s_{21}	s_{22}	…	s_{2j}	…	s_{2n}	μ''_{ij}
s_{11}	μ'_{11}	μ'_{12}	…	μ'_{1j}	…	μ'_{1n}	μ''_{1}
s_{12}	μ'_{21}	μ'_{22}	…	μ'_{2j}	…	μ'_{2n}	μ''_{2}
….	…	…	…	…	…	…	μ''_{3}
s_{1i}	μ'_{i1}	μ'_{i2}	…	μ'_{ij}	…	μ'_{in}	μ''_{n}
…	…	…	…	…	…	…	
s_{1m}	μ'_{m1}	μ'_{m2}	…	μ'_{mj}	…	μ'_{mn}	μ''_{m}

Through this matrix we can obtain the optimal alternative, which is the solution to the largest value of μ''_{ij}. There are many methods of multi-criteria decision-making that depend on fuzzy logic, and these methods have been used according to the studied decision-making issue. For example, the basic linguistic data set method focuses on decision-making issues in which data are of different patterns and that are collected from different sources, except that This method does not study each of the criteria independently and this gives them a somewhat generic characteristic, as studying detailed criteria leads to a more accurate result, and strategy games theory using fuzzy logic is appropriate for multiple decision-making issues associated with External factors that are difficult for the decision maker to control, and this type of issue is similar to the issue of multi-criteria decision-making studied regarding choosing an optimal system for wastewater treatment, therefore this method will be used to take a decision on this issue as follows [8]:

When studying the game in the matter of choosing the optimal system for wastewater treatment plants, the first player who represents the environmental engineer who is in the process of designing different types of treatment systems where each type has a set of different specifications from other systems that can be called system standards, these systems share in achieving The degree of treatment required for water while the difference points are in the standards of the systems (the basic cost, the cost of operation and maintenance, the cost of installing the sludge, the required area, the resulting noise, the spread of insects), while the second player represents the conditions surrounding the treatment system Wastewater, which can be environmental, economic or social conditions.

When the first player (the designer or the engineer) chooses a system for wastewater treatment, the second player is expected to have the worst situation for him, in each of the different surrounding circumstances.

The decision-maker who analyses the game between these two players must choose the ideal strategy, i.e. the ideal system, as the game is considered from the point of view of the

first player, where the ideal system is chosen according to the principle of min max, that is, the ideal strategy is the strategy corresponding to the best worst case of cases Selected selection (wastewater treatment systems).
The assessment will be arranged in matrices with lines representing alternatives (processing systems) and columns representing the criteria of the study as follows:
Evaluation of the experts: The experts used the linguistic expressions in the evaluation of the non-measured criteria the measured criteria were evaluated in numbers and units of each of these criteria, and tables shows the evaluation of the experts:

The evaluation of internal criteria:

Internal criteria / Treatment System	The required area (m^2/person)	The noise	Spread of insects	Invest Cost (sp/person)	Running Cost (sp/person)	Sludge Cost
Active sludge	0.2	Very High	Very Low	50.000	7500	High
Activated sludge	0.3	Moderate	Low	47.000	7500	Low
Activated sludge (surface ventilation + full blending)	0.25	High	Low	44.500	7500	High
Biological rotary disks	0.085	High	Moderate	58.500	5000	Moderate
Aerated pond	7.5	-	High	20.000	2000	Low
Aerated lagoons	2.5	Low	High	30.000	3000	Moderate
Submarine outfalls	0.07	Very Low	-	80.000	15750	-
Wetland treatment	5	-	Very High	10.000	1000	-

The evaluation of external criteria:

External Criteria / Treatment System	Difficulty of equipment availability	Difficulty of implementation	Vulnerability to odors	drizzle	Difficulty of operation	Difficult maintenance	Experience from previous systems (number of implemented units)
Active sludge	Moderate	High	Low	Very Low	Very High	High	5
Activated	High	Moderat	Very	Low	Modera	Modera	5

sludge		e	Low		te	te	
Activated sludge (surface ventilation + full blending)	High	Moderate	Moderate	High	Low	Moderate	2
Biological rotary disks	High	Moderate	Low	High	Low	Low	0
Aerated pond	Very High	Very Low	Very High	-	Very Low	Very Low	1
Aerated lagoons	Moderate	Low	Moderate	Very Low	Low	Low	1
Submarine outfalls	Very Low	Very High	-	-	Low	Very High	0
Wetland treatment	Very High	Low	Moderate	-	Low	Low	1

Expert assessment of risk criteria

Risk Factor / **Treatment System**	Machine stops (blackouts)	Administrative failure	Design errors	Execution errors	Operation and maintenance errors	Flexibility
Active sludge	Very High	Very High	High	High	High	Very Low
Activated sludge	Moderate	High	Moderate	Moderate	Moderate	Moderate
Activated sludge (surface ventilation + full blending)	High	High	High	High	High	Low
Biological rotary disks	Low	High	Moderate	Moderate	Moderate	Moderate
Aerated pond	-	Very Low	Low	Low	Very Low	High
Aerated lagoons	Low	Low	Low	Low	Low	High
Submarine outfalls	Very Low	Low	Very High	Very High	Low	Very High
Wetland treatment	-	Very Low	Low	Low	Very Low	High

Fuzzification:

The values obtained include uncertainty and therefore are assessments of a fuzzy nature, and will be represented by fuzzy numbers as follows:

Criteria / Treatment System	Efficiency level	Operating	Bad influences	Resources	Min max
Active sludge	0.382\0.005	0.382\0.240	0.382\0.526	0.382\0.027	0.005
Activated sludge	0.583\0.241	0.583\0.458	0.583\0.439	0.583\0.2207	**0.241**
Activated sludge (surface ventilation + full blending)	0.385\0.085	0.385\0.394	0.385\0.005	0.385\0.245	0.005
Biological rotary disks	0.402\0.154	0.402\0.473	0.402\0.245	0.402\0.804	0.154
Aerated pond	0.133\0.939	0.133\0.999	0.133\0.046	0.236\1.000	0.046
Aerated lagoons	0.300\0.881	0.300\0.656	0.300\0.122	0.300\0.536	0.122
Submarine outfalls	0.652\0.416	0.652\0.002	0.652\0.999	0.652\0.260	0.002
Wetland treatment	0.382\0.957	0.382\0.983	0.382\0.046	0.382\0.977	0.046

Conclusions and recommendations:

Deciding on the choice of an optimal wastewater treatment system is a complex issue with a high level of uncertainty, requiring participation from different sectors (economic, social and environmental), and therefore a multi-criteria decision. The choice of an optimal wastewater treatment system requires that the system be optimized for each of the criteria, but the impacting criteria are contradictory and there is no system to optimize for all these criteria.

It is difficult to assess the criteria affecting the choice of an optimal wastewater treatment system precisely because of the nature of the standards, as some of these criteria are not measurable, while others do not have the tools and instruments to measure them. Therefore, this issue is characterized by lack of information and data necessary for decision-making[9].

Eight general wastewater treatment systems can be discussed. The criteria affecting the choice of wastewater treatment systems can be divided into system standards and external conditions within a hierarchical structure according to the Analytic Hierarchy Process.

This type of project is characterized by the presence of several risk factors that affect the efficiency of water treatment to varying degrees depending on each system. The evaluation of the criteria for selecting an optimal water treatment system is largely based on practical experience. The performance of different systems cannot be measured against these standards using measurement tools, and there is no documentation of performance values when monitored in previous projects. In the mind of an expert who may be characterized by an optimistic or pessimistic view, according to: First, the circumstances surrounding the governing of this type of projects, and secondly the nature of his personality, which shows its impact when evaluating a process.

To reach a good assessment of the criteria governing this decision must be inferred experienced as a first step towards obtaining a good quality of data, and the second step comes to know the factors affecting the achievement of this is mainly related to the expert and the decision analyst who discusses the expert to obtain the required assessments.
The choice of the optimal processing system involves many problems both in the data and in the method of processing this data, as the data of a different nature, has been estimated by experts and language expressions have been used sometimes, and therefore are uncertain data[5].
The way these data are processed is to be considered as specific numbers or the use of multiple criteria overlay equations so that higher values of values are compensated for by small values, resulting in the loss of part of the information contained in the assessments.
The methodology presented has attempted to solve the previous issues based on the theory of fuzzy logic as a tool for solving complex problems that are ambiguous and uncertain, since the evaluation of the criteria is not specific values but fogies, thus obtaining a more realistic assessment of the wastewater treatment systems.
The choice of an optimal wastewater treatment system depends on determining the ideal strategy in the game between the engineer (or designer) and external conditions, so the mathematical model presented was based on the Fuzzy Matrix Game. The submitted model allows it to be applied to different study cases with modifications made according to the situation studied. It should be noted that this model can be applied to different decision-making issues characterized by uncertainty, lack of information and uncertainty.
It is not enough to choose the optimal wastewater treatment system, and this stage of the study should be followed by another phase that is not less sensitive than this stage, where the process of managing a wastewater treatment system requires:
1. Accuracy in the design process for each section of the plant where design errors greatly affect the efficiency of the water treatment process.
2. Accuracy in the implementation of each section of the plant where the implementation errors significantly affect the efficiency of the water treatment process.
3. Accuracy in operation and maintenance operations where operation and maintenance errors greatly affect the efficiency of water treatment process.
4. Seek in the area of finding laws that determine the process of discharging wastewater from its source and industrial contaminated water to the sewage network so that this water is treated to the required level before discharge to the sewage network.
5. The use of qualified administrative cadres and follow up the work of the plant by supervisors from the administrative body to rectify problems in a timely manner so as not to affect the efficiency of the plant in water treatment.
- Development of the model by introducing new systems derived from public systems and therefore the methodology used is a tool or guide towards finding the solution required.
- Developing the model used by introducing the relationships between the different criteria, ie, considering them as non-independent standards.
- Develop the model used based on the theory of fuzzy logic as a tool to address uncertainty by introducing uncertainty in the membership itself.
- Develop the model used based on the theory of fuzzy logic as a tool to address uncertainty by introducing uncertainty in the possibilities associated with risk criteria.
- Developing the model to allow for the creation of software to analyse multi-criteria decision-making issues characterized by uncertainty and thus obtaining results with a high level of reliability, as well as the possibility of using them in different cases by adjusting

the data according to the studied situation so that it is available to the largest number of users; These programs can also be developed to allow more than the choice of the optimal system, but beyond the procedures that follow the process of selecting the optimal system in the form of an expert system, for example.
- Perform multi-criteria decision analysis at all stages of the project and not only at the design stage.

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