

# Potential of Treated Wastewater Reuse in Industrial Symbiosis: A Case Study of Iranian Industrial Park

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## Abstract

**Aim:** This study aims to investigate the feasibility of reusing treated wastewater from the wastewater treatment plant of an industrial park to save fresh water and industrial symbiosis. **Methods:** This study is descriptive, analytical, and comparative. This study analyzed the chemical, physical, and biological characteristics of treated wastewater from the wastewater treatment plant of Hashtgerd industrial park for 2 years (2022–2023). Then, reuse options of treated wastewater were evaluated using a multi-criteria decision-making process based on the analytic hierarchy process (AHP). **Results:** Based on the obtained results, the amount of treated wastewater produced in the industrial park is up to 1200 m<sup>3</sup>/d, and by reusing it, significant savings can be made in industrial water use. The average effluent concentrations were 96.25 ± 61.78 mg/l, 46.25 ± 29.91 mg/l, 17.75 ± 10.99 mg/l, and 1635 ± 315.5 mg/l for chemical oxygen demand (COD), biochemical oxygen demand (BOD<sub>5</sub>), total suspended solids (TSS), and total dissolved solid (TDS), respectively. This treated wastewater is suitable for some reuse scenario according to the some standards and guidelines. The results of the AHP showed that the best way to treated wastewater reuse is industrial reuse (weight 0.251), which saves a lot of water consumption in industries located in the industrial park. **Conclusion:** The TDS are higher than the permitted limits for some reuse. Therefore, further treatment may be required for some reuse of treated wastewater from the Hashtgerd industrial park.

**Keywords:** Industrial park, industrial symbiosis, reuse, treated wastewater, wastewater

## INTRODUCTION

Industrial symbiosis is a cooperative relationship between different industries in an industrial area to improve resource efficiency, such as water conservation. Following this policy, industries in the industrial park cooperate in sharing treated wastewater to save water. Industrial symbiosis can promote the sustainable use of water resources in an industrial park by reducing freshwater consumption and wastewater production. Limited water resources, global water scarcity, high industrial water consumption, and environmental constraints have rapidly increased in the need for treated wastewater reuse.<sup>[1,2]</sup> These problems have prompted governments to think about water management strategies. One of the best ways to solve these problems is the reuse of treated wastewater in industry.<sup>[3]</sup> Recently, the reuse of treated wastewater from wastewater treatment plants as a resource for industrial use has been encouraged. On the other hand, the industrial use of treated wastewater as an industrial water source represents <7%

of the water supplied, which requires greater attention to the use of this source.<sup>[4]</sup> Gazor *et al.* (2021) investigated the selection of the best method for treated wastewater reuse using a analytic hierarchy process (AHP). Their study showed that it can be used in water sources in industries with many advantages.<sup>[5]</sup> Sa'ad *et al.* show that one of the solutions to minimize the consumption of fresh water in the industrial sector is the reuse of treated wastewater in the industries, that significantly save fresh water for the industry.<sup>[6]</sup> Implementing industrial symbiosis and circular economy as treated wastewater reuse can allow developing countries to grow more while

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avoiding the risks of environmental pollution and fresh water resource depletion.<sup>[7]</sup> Bauer *et al.* represented that reusing treated wastewater in industrial parks can lead to fresh water conservation, environmental pollution control, and land use reduction within the industrial parks.<sup>[8]</sup> However, for the treated wastewater to be used as industrial water resources, it must have appropriate physical, chemical, and biological properties according to the national and international standards and guidelines.<sup>[9]</sup> Multi-criteria decision-making can be very useful in selecting an effective method, from environmental, economic, social, and technical aspects, for reusing treated wastewater, especially in areas where different uses are possible.<sup>[10]</sup> The AHP method has been widely used for multicriteria decision-making in the real-world industrial problems.<sup>[11]</sup> This study selects the best method for reusing treated wastewater from Hashtgerd industrial park using the APH method. Hashtgerd industrial park, with an area of more than 250 hectares, is located at a distance of 90 km from Tehran, Iran. In this industrial park, more than 150 industries are located, where wastewater is treated by activated sludge after preliminary treatment in a centralized wastewater treatment plant. Due to the high water consumption in industries, this industrial park generates very large amount of treated wastewater and its management is very important. Our study provides a comprehensive solution to the challenges of selecting optimal treated industrial wastewater reuse, filling a critical gap in current industrial effluent reuses, and paving the way for more effective decision-making in the selection of an effluent reuse method for an industrial park. The main objective of this research was to determine the treated wastewater reuse potential using AHP of an industrial park to achieve industrial symbiosis and a circular economy.

## MATERIALS AND METHODS

### Study area

This research was a descriptive, analytical, and comparative study. Hashtgerd industrial park was built in 2017 on a 250

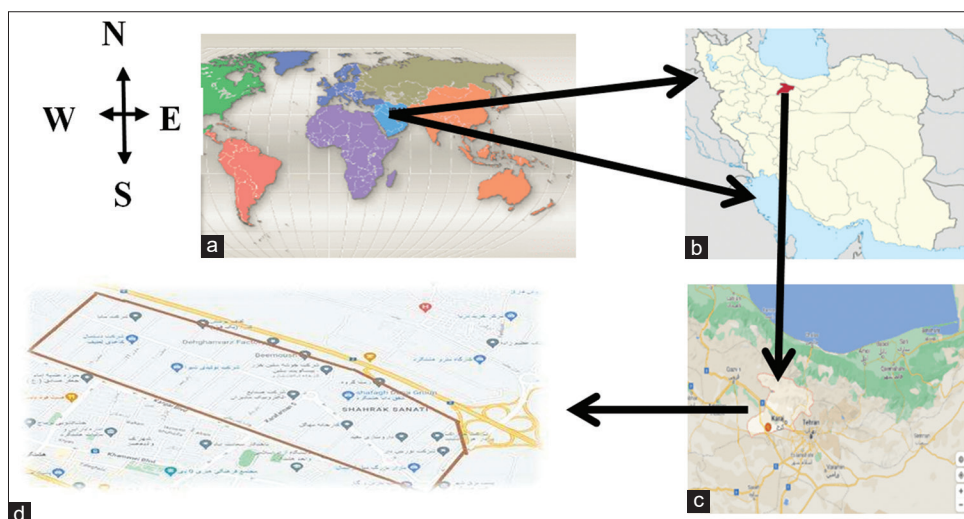
hectares plot 90 km from the Tehran-Qazvin highway. The location of the Hashtgerd industrial park is shown in Figure 1.

This industrial park includes food industries, medical and pharmaceutical equipment, machinery equipment, cosmetics and hygiene, and cellulose industries. In some industries located in the industrial park, preliminary wastewater treatment is done, and finally the wastewater of all industries enters the central wastewater treatment plant of the park. Conventional activated sludge treatment process is used at industrial park's central wastewater treatment plant. This wastewater treatment plant receives about 12.00 m<sup>3</sup>/d of wastewater from industries located in the industrial park. First, the generated wastewater enters the pumping station and screening, where coarse materials are removed, and then they enter the grit removal unit, where sand and granular materials are separated. At the next stage, the treated wastewater enters the equalization basin and enters the aeration tank, where the oxidation process of organic pollutants occurs. Then, the treated wastewater enters the sedimentation tank, and part of the activated sludge is returned to the aeration tank after settling. Finally, the treated wastewater is disinfected and discharged. Currently, most of this treated wastewater is used for irrigation purposes.

### Sampling and analyses

Data on the quality and quantity of wastewater and effluent from the centralized wastewater treatment plant were collected from the archival data that samples from the inlet and outlet of the wastewater treatment plant carried out monthly by the Hashtgerd industrial park in 2022 and 2023.

In addition, three series of composite samples of treated wastewater from the wastewater treatment plant were taken at different periods (monthly periods). The main objective of this series of sampling and analyses was to validate the available archival data for the wastewater treatment plant, and in this regard, statistical analysis was performed between the means



**Figure 1:** A map of the of the Hashtgerd industrial park, Karaj, Iran (a: map of world, b: map of iran, c: map of karaj, d: map of the hashtgerd industrial park)

of the same variables in the tested and archival data, and no significant differences were observed between the main quality parameters. To compare the means, the Kolmogorov–Smirnov test was used to verify the normality of the data, and the one-way analysis of variance and Tukey's *post hoc* test were used for the comparison.  $P > 0.05$  was considered statistically significant. These statistical analyses have also been used to compare wastewater quality variables. All statistical analyses were conducted using SPSS software version 22.0 (IBM Corporation, Armonk, NY, USA).

The inductively coupled plasma mass spectrometry (ICP-MS) (Agilent 7900 ICP-MS instrument) was used for metals analysis in samples.<sup>[12]</sup> The pH-values were measured using a digital pH meter (Jenway 3510 digital pH meter). Turbidity was determined using a AL 450T-IR– turbidimeter model, Aqualytic company. In addition, other physical, chemical, and microbiological tests such as COD, BOD<sub>5</sub>, TSS, total dissolved solid (TDS), total coliform, Fecal coliform, PO<sub>4</sub>, Sulfate, Sio<sub>2</sub><sup>-</sup>, and CL<sup>-</sup> on effluent and wastewater were performed according to standard methods for the examination of water and wastewater.<sup>[13]</sup>

Each experiment was performed in triplicate, and the average was used. In this study, firstly, the existing conditions for the treated wastewater from the centralized wastewater treatment plant of the industrial park were described and then assessed for reuse in 7 of the world's most common uses, including using discharge to surface water, environmental uses, urban consumption, discharge to absorbent well, recreation and aquaculture, industrial consumption, and agricultural consumption.

In the comparative research phase, the results of the descriptive study were compared and contrasted with the WHO guidelines, the U.S. Environmental Protection Agency (EPA) regulations, Iranian standards, and other valid scientific documents.<sup>[14-18]</sup>

### The analytic hierarchy process to select treated wastewater reuse

Finally, after recognizing the possible methods for reusing treated wastewater, the AHP was used to prioritize the methods. The most important criteria and sub-criteria for wastewater reuse were identified through reviewing literature, and consultation with experts.<sup>[5,10,19,20]</sup> The criteria considered in this study include environmental, technical, cultural-social,

and economic aspects. The sub-criteria include preventing health risks, reducing environmental pollution, enhancing water storage, general admission, cooperation between institutions and governments, applicability, and income generation.

To determine the importance and prioritization of the criteria and options, a checklist was prepared, and the opinion of 25 people consisting of university professors, specialists, and experts of the industrial park was received on the treated wastewater consumption. To determine the relative weight of the criteria, the AHP which Saaty first proposed was used.<sup>[21]</sup> This method is through two-by-two comparison, creates a normalized matrix, and relies on the judgment of experts to extract the priority criteria. This analysis helps to choose the most appropriate option ahead. Calculating the weights from the normalized matrix is performed by calculating the arithmetic mean for each row of the matrix. Finally, version 3 of Super Decision software (The Creative Decisions Foundation, University of Pittsburgh, USA) was used for the analysis.

## RESULTS

The number of industries located in Hashtgerd industrial park, including machinery equipment industries, cosmetics industries, food industries, medical and pharmaceutical industries, and cellulose industries, were 97, 29, 20, 17, and 15 items, respectively. In Hashtgerd industrial park, the average water consumption is 1600 m<sup>3</sup>/d, and the wastewater produced is 1200 m<sup>3</sup>/d. The quality and quantity of selected pollutants in wastewater from industries located in Hashtgerd industrial park are shown in Table 1. The highest amount of BOD, TDS, and COD wastewater is associated with mechanical industries, and the lowest amount of BOD, COD, and TDS is associated with medical and pharmaceutical industries ( $P < 0.05$ ).

The mean wastewater composition for BOD<sub>5</sub>, COD, TSS, and turbidity of the influent and the effluent of the centralized wastewater treatment plant of Hashtgerd industrial park is shown in Table 2. At the central wastewater treatment facility situated within the industrial park, the treatment process successfully removed 90.15% of COD, 90.36% of BOD, 88% of turbidity, and 97.3% of TSS.

The average values of pollutants in the treated wastewater of the centralized wastewater treatment plant of Hashtgerd

**Table 1: The quality and quantity of selected pollutants in industrial wastewater of industries located in hashtgerd industrial park**

Industry	Wastewater quantity* (m <sup>3</sup> /day)	BOD <sub>5</sub> * (mg/L)	COD* (mg/L)	TDS* (mg/L)
Cellulose industries	103.8±2	2714±377	5712±865	734±60
Medical and pharmaceutical industries	106.8±3.5	780±15	1557±29	721±71
Food industry	150.6±5.9	4962±718	13,235±1611	1001±109
Cosmetics industry	234.9±2.9	2522±174	5060±357	1307±70
Machinery equipment industries	652.9±20	9453±162	18,961±327	4480±96

\*Mean±SD. SD: Standard deviation, TDS: Total dissolved solids, BOD<sub>5</sub>: biochemical oxygen demand, COD: chemical oxygen demand, COD: chemical oxygen demand

industrial park for 2 years (2022–2023) and the potential for agricultural, recreational, industrial use, and discharge to surface water and wells according to the Iranian, WHO, the U.S. Environmental Protection Agency (EPA), and The Food and Agriculture Organization (FAO) guidelines and regulations are presented in Table 3. The highest value at the treatment plant outlet is reported for COD (96.25 ± 61.78), TDS (1635 ± 315.54 mg/l), and Na (631.7 mg/l). As indicated in the table, while the effluent complies with Iranian standards for agricultural use, additional improvements to

the COD and BOD<sub>5</sub> parameters of effluent are required to align with the guidelines and standards set by the WHO, USEPA, and FAO.

Table 4 also compares the quality of the treated wastewater from the centralized wastewater treatment plant of Hashtgerd industrial park for four categories of industrial use, including highly sensitive, sensitive, relatively sensitive, and less sensitive industries. The results indicated that the TDS and COD concentrations, recorded at 96.27 mg/L and 635 mg/L, respectively, exceeded the acceptable levels for use in certain industrial sectors.

**Table 2: The influent and the effluent quality of the centralized wastewater treatment plant of Hashtgerd industrial park**

Variables	Unit	Influent	Effluent	Removal (%)
COD	mg/L	981±124	96±62	90.15±4.34
BOD <sub>5</sub>	mg/L	479±71	46±30	90.36±5.18
TSS	mg/L	658±49	18±11	97.31±1.11
Turbidity	NTU	105±23	13±5	88.10±5.36

TSS: Total suspended solids, BOD<sub>5</sub>: biochemical oxygen demand, COD: chemical oxygen demand

### Analytic hierarchy process of treated wastewater reuse from Hashtgerd industrial park

Figure 2 shows a priority list for treated wastewater reuses. As a result, industrial use (weight 0.251) had the highest value, followed by agricultural use (weight 0.215). The lowest weight is associated with recreational use and aquaculture (weight 0.035). The results showed that, based on the weight of each item, the methods of wastewater reuse in order of priority include industrial use, agricultural use, discharge to absorbent

**Table 3: The potential of the treated wastewater from the Hashtgerd industrial park wastewater treatment plant for reuse in agriculture, discharge to surface water, and wells**

	Concentration of treated wastewater from Hashtgerd industrial park*	Iranian standard for treated wastewater reuses			Agricultural water quality according to the WHO, USEPA and FAO guidelines		
		Agricultural uses	Discharge to surface water	Discharge to well	WHO	USEPA	FAO
BOD <sub>5</sub> (mg/L)	46.25±29.91	100	30 (50**)	30 (50**)	10–30	10–30	-
COD (mg/L)	96.25±61.78	200	60 (100**)	60 (100**)	-	-	-
TSS (mg/L)	17.75±10.99	100	40 (60**)	-	30	30	50
TDS (mg/L)	1635±315.5	-	***	****	-	-	2000
Total coliform (n/100 mL)	16.18±9.4	1000	1000	1000	200	1000	1000
Fecal coliform (n/100 mL)	10.25±7.02	400	400	400	200	200	200
PO <sub>4</sub> (mg/L)	<0.05	-	6	6	-	-	-
Turbidity (NTU)	12.50±5.44	50	50	-	-	5	≤2
PH	7.7	6–8.5	6.5–8.5	5–9	6–9	6–9	6.5–8
Fe (mg/L)	0.27	3	3	3	5	5	5
Mn (mg/L)	<0.05	1	1	1	0.2	0.2	0.2
Pb (mg/L)	0.01345	1	1	1	-	5	5
Ni (mg/L)	0.0143	2	2	2	0.2	0.2	0.2
Cr (mg/L)	<0.05	2	2	2	0.1	0.1	0.1
Sn (mg/L)	<0.05	-	-	-	-	-	-
Mo (mg/L)	0.01855	2	0.01	0.01	0.01	-	-
Na (mg/L)	631.7	-	-	-	-	-	-
Hardness (mg/L)	488	-	-	-	-	-	-
Alkalinity (mg/L)	495.3	-	-	-	-	-	-
Sulfate (mg/L)	388.25	500	400	400	-	-	-
Sio <sub>2</sub> <sup>-</sup> (mg/L)	38.5	-	-	-	-	-	-
CL <sup>-</sup> (mg/L)	382.5	600	600	600	-	<355	-

\*Mean±SD, \*\*Instantaneous standard, \*\*\*Discharges with concentrations exceeding those specified in the table will be permitted if the increase in chloride, sulfate, and dissolved substances in the effluent does not exceed 10% compared to the water consumed, \*\*\*\*Discharges with concentrations exceeding those specified in the table will be permitted if the effluent does not increase the concentration of chloride, sulfate, and dissolved substances of the receiving source within a radius of 200 m by more than 10%. SD: Standard deviation, TDS: Total dissolved solids, TSS: Total suspended solids, FAO: Food and Agriculture Organization, USEPA: United States Environmental Protection Agency, BOD<sub>5</sub>: biochemical oxygen demand, COD: chemical oxygen demand

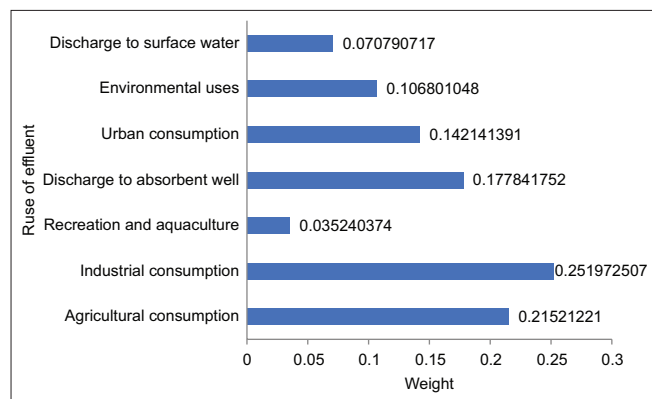
wells, urban use, environmental uses, discharge to surface waters, recreational and aquaculture uses.

The weighting of effective parameters in industrial reuses of treated wastewater from Hashtgerd Industrial park is shown in Figure 3. The highest weight is related to water saving, cooperation of governmental organizations, and earned

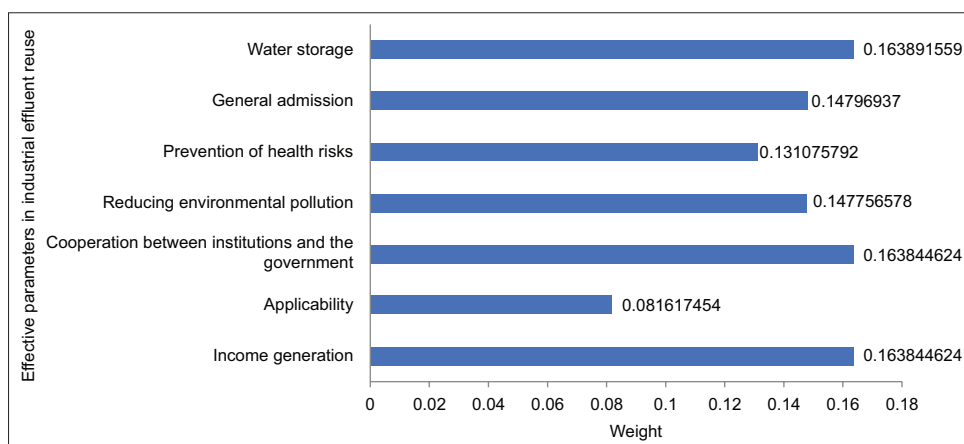
income (weight 0.1638), and the lowest weight is related to applicability (weight 0.0816). In addition, the results show that the prevention of health risks and reducing environmental pollution can also be influencing factors in choosing industrial reuse of effluent in industries located in Hashtgerd industrial park.

### DISCUSSION

The results of this study show that the most active industries located in Hashtgerd industrial park are related to machinery equipment (55%). The highest amount of wastewater ( $652.9 \pm 20 \text{ m}^3/\text{d}$ ), BOD ( $9453 \pm 162 \text{ mg/l}$ ), TDS ( $4480 \pm 96 \text{ mg/l}$ ), and COD ( $18961 \pm 327 \text{ mg/l}$ ) belongs to this category of industries. Therefore, by separating or pretreating this part of the wastewater of the industrial park before discharging it to the central wastewater treatment plant, the quality of the final treated wastewater can be significantly improved. The machinery equipment industry is one of the highest water-consuming groups because it uses metals to produce and prepare equipment.<sup>[23]</sup> Water is mainly used in these industries for equipment cooling, processes, product cleaning, and sanitary application.<sup>[24]</sup> Studies conducted by Tong *et al.*<sup>[25]</sup> have also shown that the metallurgical industry



**Figure 2:** The weighting for the choice of the method of reuse of treated wastewater from Hashtgerd industrial park



**Figure 3:** The weighting of effective parameters in industrial reuses of treated wastewater from Hashtgerd industrial park

**Table 4: Adjusting the quality of Hashtgerd industrial park’s treated wastewater for four classes of industrial use**

	Concentration of treated wastewater from Hashtgerd industrial park	Four class of use of industrial water <sup>[22]</sup>			
		Low sensitive	Relatively sensitive	Sensitive	Very sensitive
COD (mg/L)	96.25	0–75	0–20	0–10	0–5
TDS (mg/L)	1635	0–1000	0–500	0–100	0–50
pH	7.7	5–10	5–10	6–10	7–9
TSS (mg/L)	17.75	0–100	0–10	0–5	0–1
Hardness (mg/L)	488	0–500	0–250	0–100	0–1
Mn (mg/L)	<0.05	0–1	0–0.3	0–0.05	0–0.01
Fe (mg/L)	0.27	0–1	0–0.3	0–0.1	0–0.05
Alkalinity (mg/L)	495.3	0–500	0–150	0–75	0–50
Sulfate (mg/L)	388.25	0–500	0–250	0–100	0–20
Sio <sub>2</sub> <sup>-</sup> (mg/L)	38.5	0–50	0–20	0–10	0–5
CL <sup>-</sup> (mg/L)	382.5	0–500	0–200	0–100	0–20

TDS: Total dissolved solids, TSS: Total suspended solids, COD: chemical oxygen demand

has a high consumption of fresh-water resources producing a large volume of wastewater and a high concentration of pollutants. Considering that most of the wastewater generated in the machinery equipment industries is related to the process of washing and cleaning with fresh water; therefore, a large portion of water can be reduced by changing the process or using new and environmentally friendly methods or techniques<sup>[26]</sup> which will ultimately lead to the minimum amount of wastewater generated.

The treated wastewater from Hashtgerd industrial park can be reused for irrigation according to Iranian treated wastewater standards [Table 3], but considering the strong requirements of industrial water in Hashtgerd industrial park and its AHP [Figure 2], the best way to reuse this treated wastewater is industrial use (weight 0.251). Although the effluent meets Iranian standards for agricultural use, further treatment to the quality improvement of effluent are necessary to fully comply with the guidelines and standards established by the WHO, USEPA, and FAO.<sup>[14,18]</sup> In addition, reusing industrial park treated wastewater in the industries located in Hashtgerd industrial park is the basic pillar of industrial symbiosis, a business strategy for implementing a circular economy.<sup>[27]</sup> Furthermore, due to the ecotoxicological and health concerns of new and emerging pollutants in industrial treated wastewater and environmental safety, it may be better to use the treated wastewater in the industry and not discharge it into the environment and agricultural use.<sup>[28]</sup>

The industrial park's treated wastewater can be used in industrial units less sensitive to water supply quality [Table 4]. It should be noted that the suggested values are desirable for industrial water resources. Therefore, many industries in Hashtgerd industrial park fall into the low-sensitive group that can use from generated treated wastewater. The group of industries with low sensitivity includes water used in chemical industries, cooling water, surface cleaning water, water used for transporting materials, landscape irrigation, and firefighting water, most of these units are located and available in the Hashtgerd industrial park. These units can provide part of their water needs from generated treated wastewater. The results of this study show that the quality of treated wastewater is consistent with several industrial uses in the industrial park, and in some cases, by using more treatment methods such as reverse osmosis, the reuse conditions can be achieved for other purposes.<sup>[24,29]</sup>

The reuse of treated wastewater in industries offers significant economic advantages, particularly in regions facing water scarcity.<sup>[30]</sup> However, the challenges associated with implementing industrial effluent reuse cannot be overlooked. The key issues include the presence of toxic chemicals, harmful solvents, volatile organic compounds, and other priority pollutants in wastewater, many of which lack established standards. Addressing these challenges requires the adoption of effective treatment technologies. In addition, stringent pollution control laws and their proper enforcement play a crucial role in mitigating these issues.<sup>[30]</sup>

Currently, most effluent from the hashtgerd industrial park is used for agriculture, the limitation of which could be unknown pollutants in the treated wastewater. While reuse of water in industrial parks, it is possible to use treated wastewater in parts of the industries that require lower water quality, and in this way, the annual cost of the water of the industrial park is reduced.<sup>[31]</sup> Hashtgerd industrial park has many low-sensitive industries, such as chemical, paper, textile, and steel industries, and this treated wastewater can be used there. Livia *et al.* indicated that lower-quality treated wastewater can also be used for industrial purposes but is better for cooling purposes only.<sup>[29]</sup> Tong *et al.* also showed that the quality of treated wastewater generated from industrial parks in China can be used as industrial process water, agriculture and horticulture water, and discharged into the environment.<sup>[32]</sup> Of course, it should be noted that the pretreatment of industrial park wastewater, especially in independent industrial units, can play an important role in increasing the performance of the central treatment plant and reducing the risks related to the reuse of produced treated wastewater. Some industries in Hashtgerd industrial park that produce high BOD, COD, and TSS, such as food, cardboard, and paper, require pre-treatment to reduce these pollutants. Pandey and Jagnnath pointed out that for the safe reuse of industrial treated wastewater, due to their variable and complex quality, the current treatments may not meet the need for treated wastewater reuse, and additional treatments such as reverse osmosis, microfiltration, nanofiltration, and membrane bioreactors are needed to remove all pollutants.<sup>[33]</sup>

In this study, industrial use is the best method chosen to reuse industrial wastewater based on the AHP (weight 0.251). In general, industrial uses of industrial-treated wastewater are safer than other uses in terms of human health and environmental impact. The results of our study are consistent with the results of Azbari *et al.* (2022) concluded that due to the variable of the quality of industrial-treated wastewater, it is necessary to avoid the discharge of industrial-treated wastewater in the environment and water resources.<sup>[34]</sup> The results of our study are consistent with the results of the study of Gazor *et al.*<sup>[5]</sup> and Azbari *et al.*<sup>[34]</sup> In both studies, the AHP method was employed to determine the optimal approach for selecting wastewater reuse options, resulting in weights about similar to those identified in our research for industrial-treated wastewater reuse.

In addition to protecting the environment from pollution, industrial reuse of treated wastewater also has many economic benefits, so today, the circular economy and industrial symbiosis are of great interest in industrial wastewater reuse management.<sup>[7,35,36]</sup> However, water stress and emerging pollutants in water due to industrial activities have created important challenges for sustainable water management, in which a circular economy can be a solution to recover water from industrial wastewater.<sup>[35]</sup> Industrial symbiosis' causes fresh-water reduction, and wastewater reduction can promote the sustainable use of water resources in the industrial park.<sup>[36]</sup> Some studies based on the AHP showed that the industrial use

method from treated wastewater with a weight of 0.17 is the priority.<sup>[34,35]</sup> Furthermore, the study by Tong *et al.*<sup>[32]</sup> on water reuse systems in an industrial park showed that the amount of reuse from industrial treated wastewater significantly affects the environmental performance index. Bauer *et al.* showed that the reuse of industrial treated wastewater is appropriate in industrial parks, especially those located in water-stress areas and with high water demands.<sup>[37]</sup>

According to the American Boiler Manufacturers Association and USEPA, treated wastewater from Hashtgerd industrial park can be used as boiler Water in drum operating pressure (psig) 0-450. As well as, with proper controls or further treatment of treated wastewater from Hashtgerd industrial park, it can be reused on-site or at other industrial site facilities for many industrial purposes, including material washing, water washing, bin and pallet washing, firefighting, cooling, production line, pH adjustment, boiler or cooling tower feed water supplement.<sup>[14]</sup>

## CONCLUSION

The results of this study show that the Hashtgerd industrial park produces 1200 m<sup>3</sup>/d of wastewater, which has high COD, BOD, TSS, and TDS concentrations. At the central wastewater treatment plant located in the industrial park, 90.15%, 90.36%, and 97.3% of COD, BOD, and TSS were removed during treatment, respectively. Due to its quality, treated wastewater can potentially play an important role in supplying industrial water to industrial parks. The results of AHP compare seven methods of reuse, including industrial use, agricultural use, discharge to surface water, environmental use, urban, recreational, and aquaculture use, and discharge to an absorbent well, showed that the best method for reuse of production wastewater is industrial use (weight 0.251), which, however, provides significant savings in the amount of freshwater consumption in the industries located in the industrial park. TDSs and some other parameters of treated wastewater from Hashtgerd industrial park are more than allowed for some uses, which means that this treated wastewater must be reused for limited purposes and requires further treatment. The treated wastewater quality of the Hashtgerd industrial park was placed in the first group, the group with low sensitivity, by applying the index of industrial water groups. As a result, treated wastewater can be used for cooling water, surface washing water, chemical industries, process water in some industries, water for transporting materials, irrigation, and firefighting. Much industrial production is related to water supply and wastewater treatment. Industries are encouraged to lower production costs by utilizing treated wastewater as an alternative water source to address. Additionally, in light of increasing water scarcity and the need to mitigate environmental pollution, policymakers must establish the regulations supporting industrial wastewater reuse, industrial symbiosis, and the advancement of the circular economy.

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## Ethics Code

IR.ABZUMS.REC.1401.240.

## Conflict of interest

The authors declare that there is no conflict of interest.

## Authors' contributions

Tayebeh Bolhasani: Conceptualization, Methodology, Project administration, Validation, Writing, Analysis and interpretation of data; Hatam Godini: Conceptualization, Formal analysis, Methodology, Supervision, Writing – original draft, Writing – review and editing; Mohammad Darvishmotevalli: Drafting of the manuscript, Validation, Writing – review and editing; Jamshid Rahimi: Study concept and design, technical support.

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