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OPTIMIZING RESOURCE ALLOCATION IN THE BLACK SEA TR83 AREA OF TÜRKİYE: ADVANCING TOWARDS AN INDUSTRIAL CIRCULAR ECONOMY

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Abstract: The TR83 region in Türkiye is recognized as one of the leading industrial centers of the Black Sea region with its efficient use of resources and wide range of activities. In the project carried out jointly by the University and the Central Black Sea Development Agency, the potential for optimizing resource use in the industrial sector of the region was evaluated to demonstrate circular economy applicability. Research was conducted to determine the current situation in the sector and to draw up a road map for the future. These surveys followed by a comprehensive field survey, where the data was processed and analyzed with the guidance of experts. Additionally, a Data SWOT Analysis was undertaken. In the research, the responses of companies in Amasya, Çorum, Samsun and Tokat provinces were analyzed. The findings highlighted the importance of implementing resource efficient approaches in the industrial sector. The proposed measures advocate the adoption of resource-efficient goods and the implementation of a circular economy strategy. The study also aims to identify requirements for environmentally friendly design and promote the use of best practices in industrial sectors and highlighted the need for a synchronized effort to achieve a future that is both ecologically sustainable and resource-optimized in the TR83 region.

Keywords: Circular economy, Economic potential, Environmental sustainability, Industrial infrastructure TR83 region, Resource efficiency

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1. Introduction

The exponential growth of the worldwide population and economic prosperity has caused a substantial increase in living standards and needs, leading to the exhaustion of resources (Weterings et al., 2013). Enhancing resource efficiency is essential for mitigating environmental deterioration and facilitating affluence for a burgeoning population. Implementing policies and activities aimed at enhancing resource efficiency might effectively decrease global resource extraction while also stimulating economic activity (Nong et al., 2023). Recycling is crucial for optimizing resource efficiency by maximizing the use of materials and products (Schmidt, 2010). Resource efficiency, defined as the capacity to utilize resources in a manner that minimizes waste and optimizes productivity, is of utmost importance for achieving sustainable development and enhancing economic competitiveness (Worrell and Reuter, 2014). Implementing policies and activities aimed at enhancing resource efficiency might effectively decrease worldwide resource extraction and greenhouse gas emissions, while simultaneously stimulating economic activity (Nong et al., 2023). The Rural Development strategy of the European Union is crucial in attaining resource efficiency goals (Herrmann, 2018). The results emphasize the significance of resource efficiency in tackling environmental issues and advancing sustainable development. The imperative to enhance resource efficiency considering diminishing natural resources and environmental deterioration is an urgent concern (Horodetska et al., 2022). The development of industrial strategies that prioritize the use of best available techniques and secondary resources can accomplish this objective (Skobelev, 2021). It is essential to identify and implement technologies, products, and strategies that have a high potential for resource efficiency (Rohn et al., 2011). Optimizing energy utilization in production is crucial for minimizing resource use and waste (Ross, 1992). However, a lack of knowledge, potential approaches, limited financial accessibility, and poor human capabilities prevent businesses from adopting resource-efficient and environmentally friendly production methods (Vorfolomeiev and Vorfolomeev, 2019). To tackle these difficulties, organizations should prioritize the economical and effective utilization of resources and energy during manufacturing, which may

lead to cost savings and enhance competitiveness (Nong et al., 2023). Moreover, the notion of highly efficient factories that maximize their influence on the surrounding environment might serve as a crucial approach for competitive and sustainable production (Lentes et al., 2016). Andriushchenko (2022) devised a strategic plan for overseeing the region's capacity for innovation, whereas Konash and Nasr (2022) underscored the significance of comprehending the intricate interplay of technology, economics, and society. Reaney et al. (2023) emphasized the necessity of a well-established infrastructure and specialized skills for the advancing information systems and business process management settings. Integrating with local government to guarantee resource efficiency is of paramount importance for a growing nation since it promotes a circular economy model (Hossain et al., 2023). Finally, Motte et al. (2022) emphasized the importance of technological variables and professional competence in attaining effective administration in public management. These studies offer vital insights that contribute to the growth of the region. Several two research have been carried out to meet the demand for technological progress and higher rates of employment in the TR83 Region Market. "Several studies have been conducted to meet the demand for technological advancement and increased employment rates in the TR83 Region market. It has been determined that there has been no study on resource efficiency needs analysis in the region, and the first resource efficiency needs analysis report specific to the region has been prepared by filling this gap with this study.

1.1. Literature Review

Map of Türkiye and TR83 Region in the Black Sea in Türkiye was given in Figure 1.

Resource efficiency in industry is a crucial element of sustainable development, offering the possibility of substantial cost reductions (Nong et al., 2023). This notion has had significant historical significance and currently plays a crucial role in the shift towards a circular economy (Schmidt et al., 2019, Van and Fadeeva, 2020). Nevertheless, there is a dearth of agreement over the methodology for quantifying resource efficiency, resulting in many divergent methodologies and techniques (Sfez et al., 2017). This emphasizes the necessity for standardized assessment techniques to guarantee comparability and suitability of resource efficiency computations in the industrial sector. Studies on resource efficiency measures have discovered several elements that influence their adoption, such as market circumstances (Delmas and Pekovic, 2015). Although the use of natural resources is increasing, there has been insufficient action taken to reduce their usage. This emphasizes the importance of implementing effective solutions to increase resource efficiency (Rohn et al., 2014). Frohling et al. (2012) introduced a method that uses material flow analysis to improve resource efficiency in production and recycling networks. This approach emphasizes the investigation of both technological and economic factors, as well as ecological considerations. A comprehensive enhancement plan has been established for the European metal mechanic industry, encompassing a decision-making toolkit to pinpoint opportunities for conserving resources (Blume et al., 2017). These studies emphasize the significance of resource efficiency measures in tackling environmental and economic concerns. Several metrics have been created to assess the effectiveness of resource utilization in different sectors (Ingaramo et al., 2009) presented eco-efficiency indicators for water and wastewater management in the sugar cane sector, whereas (Henriques and Catarino, 2017) suggested the sustainable value indicator for enhancing energy efficiency in wastewater treatment facilities. A study conducted by Wang et al. (2017) examined the interconnection between water, energy, and emissions in China's steel sector. It emphasized the possibility of employing technology-driven approaches to decrease resource consumption and emissions. Oliveira-Esquerre et al. (2009) introduced a system for managing water and wastewater in the petrochemical sector. In that study, it highlights the significance of process variability in attaining efficiency. These studies highlight the need to use indicators particular to each business and the possibility of making resource efficiency gains through technology. Various studies have emphasized the potential advantages of investing in resource efficiency in the industrial sector. Jollands and Hirsch (2018) highlight the importance of financial infrastructure and project finance in motivating such investments, especially in developing economies.

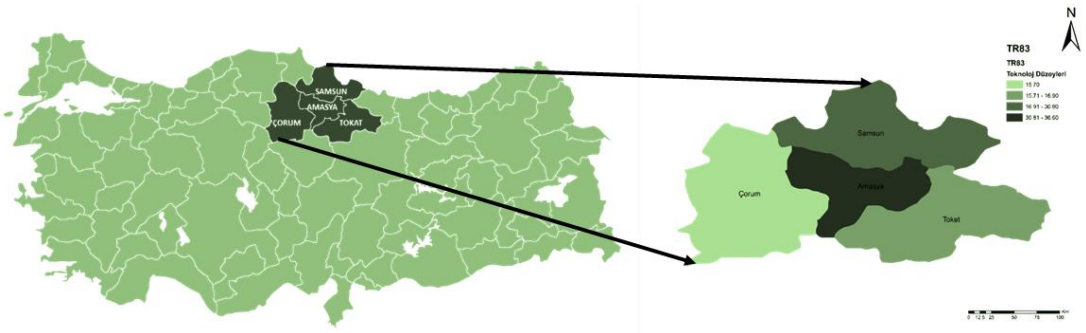

Figure 1. Map of Türkiye and TR83 region in the Black Sea in Türkiye.

Domenech and Bahn-Walkowiak (2019) presents concrete illustrations of resource-efficient technology and goods, whereas Bassi et al. (2012) emphasizes the beneficial effects of investing in energy, water, and waste efficiency within the industrial sector. Ozbugday et al. (2020) provide more evidence that resource efficiency investments have a beneficial impact on the growth performance of European small and medium-sized enterprises (SMEs). These studies highlight the potential of resource efficiency initiatives to provide environmental and economic advantages in the sector. Various studies have examined the impact of rules and self-regulation on the promotion of environmentally friendly industries. Hillary and Thorsen (1999) discovered that neither of the methods had achieved complete success in this aspect, although (Tukker, 2015) emphasized the global potential of cleaner manufacturing. In his study, (Maio et al., 2017) specifically examined China's endeavours efforts in this field, with a special emphasis on the development and execution of policies related to cleaner industrial systems. These studies emphasize the significance of both domestic and global legal matters in promoting resource efficiency and environmentally friendly industries. The European Union (EU) has been leading the way in advocating for resource efficiency and the circular economy, specifically emphasizing cleaner manufacturing and industrial symbiosis. Cainelli et al. (2017) emphasize that environmental policy has a crucial role in promoting the adoption of eco-innovations focused on resource efficiency. Meanwhile, Camilleri (2020) underscores the importance of sustainable production and consumption behaviours within the circular economy. Van Berkel and Fadeeva (2020) emphasize the advantages for businesses and the whole economy that come from resource efficiency and circularity. Ewijk (2018) examines the economic benefits, obstacles, and policies associated with these ideas. These studies emphasize the significance of resource efficiency in the European Union's attempts to shift towards a circular economy. Resource efficiency, especially within the framework of the circular economy, is a crucial catalyst for achieving both economic and environmental advantages (Muller, 2012). This is emphasized by the necessity for an efficiency revolution aimed at diminishing consumption and generating competitive advantages (Bilgen and Sarıkaya, 2016). Optimizing energy use is essential, since a comprehensive strategy for meeting future energy needs should prioritize the adoption of energy-efficient technologies to minimize environmental harm and enhance economic benefits (Hanley et al., 2006). Nevertheless, the effects of a stimulus aimed at improving energy efficiency on both the economy and the environment are intricate, since it may lead to unforeseen outcomes such as heightened energy usage and pollution (Hepbasli and Ozalp, 2003). Several studies have investigated the level of resource efficiency in the industrial sector of Türkiye. But TR83 was behind it. Hepbasli and Ozalp (2003) and Utlu and Hepbasli (2007) emphasize the significance of energy efficiency, with Utlu and Hepbasli (2007) especially examining the energy utilization efficiencies in different subsectors. Ozbilen et al. (2019) expands upon this discourse by examining the forecast of resource-efficient capacity within the Turkish manufacturing sector, highlighting the importance of implementing cleaner production practices. Onut et al. (2008) adds to this discourse by assessing the optimal energy sources for the industrial sector using the analytic network approach. These studies emphasize the importance of resource efficiency in the Turkish industrial sector and offer useful insights for future studies and policy development. An extensive literature review has been carried out to emphasize the importance of requirement analysis in business, specifically in relation to resource efficiency (Lieder, 2014). The original data has been gathered from much scientific research, reports, news stories, and other sources. The survey and expert integration have generated secondary data. Moreover, the study has highlighted the necessity of using a methodical assessment strategy to measure resource efficiency and cost effectiveness in production systems, especially in small and medium-sized companies (Lieder, 2014). The results of this study are anticipated to have a favorable influence on the cost-benefit ratio within each industry, as they establish a foundation for the formulation of resource-efficient strategies and pricing policies (Shmygol et al., 2023).

2. Materials and Methods

An exhaustive examination of resource efficiency in the TR83 region was carried out in three stages. In TR83 Region a total of 76 company, 6553 personal, and 103 industrial area has been surveyed. The initial stage encompassed the distribution of information, a comprehensive examination of existing literature, and a survey. Subsequently, the second stage entailed gathering expert perspectives and evaluating the efficacy of available resources. The concluding stage involved conducting interviews and engaging in field research, specifically emphasizing the SWOT analysis and on-site consultations. This study highlighted the significant influence of resource efficiency on both the economy and the environment.

2.1. Field Survey

2.1.1. Annexe-I

This study examined the aspects of waste, water, wastewater, energy, and emissions inside the organized industrial zones (OIZ's) of the TR83 region. The questionnaire was converted into a set of 57 questions that pertain to these specific subjects. Participants were instructed to select either "positive", "negative" or "uncertain" in response to each subject matter in the current and forthcoming periods. The responses were gathered in a manner that allows for statistical reporting. The OIZ administration was thereafter requested to

prioritize three needs from the listed ones to address the most important needs within the region and provinces. The sufficiency percentages for each need were compared to assess their respective influence.

2.1.2. Annexe-II

This part specifically addressed the utilization of raw materials, the optimization of resource efficiency, and the management of waste. The analysis encompassed the evaluation of labor force proficiency and employment, selection, and utilization of raw materials, as well as their management, water and energy consumption and their management, and waste management. The questionnaire also encompassed inquiries regarding the augmentation of capacity, research, and development (R&D), innovation, efficiency studies, and future endeavours of enterprises operating within the OIZ.

2.2. SWOT Analysis

The sustainability and adoption level of resource efficiency studies in these developer OIZs were evaluated with SWOT analysis.

2.3. Expert Integration

The TR83 Region Resource Efficiency Needs Analysis emphasized the need for collaboration, skill development, and environmentally friendly production techniques (Ardali, 2020). The findings align with Comtois, 2007 which underscored the imperative of integrating sustainable development methods in the maritime transportation industry. Boden et al. (2016) emphasized the importance of stakeholder gatherings and mutual learning to implement in the regional smart specialization programs. Welfens et al. (2017) and Jaegersberg et al. (2007) highlighted the significance of sustainable development, environmentally friendly production, and inventive approaches in eco-industrial networks and regional supply chains. Collective data that backs the integration of experts and the focus on collaboration, enhancement of skills, and adoption of sustainable manufacturing methods in the TR83 Region.

2.4. Data Analysis

A remarkable guidance has been discovered that provides both value and quantity, enabling every sector to ascertain the precise actions required to enhance their resource efficiency in waste, wastewater, energy, and emissions. This course of action was identified after the completion of data collection, with the purpose of generating the demand for the resource efficiency sector in the TR83 region. Several software programs, such as SPSS, were employed to do the study, and the findings were transformed into percentages to enhance understanding. Charts and tables can be useful for diagram-based analysis in specific situations, facilitating people's understanding of numerical issues.

3. Results and Discussion

In Annex-I, research has been conducted to evaluate the resource efficiency potential and structure of the region in the TR83 region for the purpose of cooperation. The survey covered corporate organizations from different sectors, especially companies that make significant contributions to the economy, exhibit high employment rates and actively conduct research and development activities. According to the survey, some companies in the region had 100% foreign capital, while some had domestic capital. Businesses utilized varying levels of workforce, utilized energy, natural gas and water services, and handled waste management efficiently. They established quality control systems, monitored the inputs and outputs of production, and were aware of developing technology. 60% of companies collaborated with universities or research centers and received government funding for research and development. Many businesses have committed to increasing their workforce without making formal agreements with stakeholders.

Table 1 presents a concise overview of the results pertaining to waste management, water and wastewater management, energy consumption, and knowledge of emissions among the participants. Concerning waste management, most participants had information regarding the specific sort of waste generated and the corresponding costs involved. Most participants additionally protect storage sites from external influences. Regarding water and wastewater management, a considerable number of people have information regarding their monthly water usage, upkeep, sanitation, and methods for disposing of sludge in their personal treatment facilities. Nevertheless, a significant proportion of individuals lack awareness in these areas. Concerning energy consumption, most participants demonstrate awareness of their monthly energy usage and express a desire to install motion sensor lighting systems. Regarding emission awareness, most participants have information about the sources of emissions but lack understanding of how emissions are categorized and measured. Certain participants do not possess adequate infrastructure for controlling and managing air pollution emissions. In Annex-II, the TR83 area has implemented initiatives to foster competitive manufacturing and expedite productivity and industrial development. A collaborative resource efficiency assessment study was done with Central Black Sea Development Agency - Ondokuz Mayıs University to analyze the potential for resource efficiency and enhance the organizational framework of enterprises in the TR83 region. The poll focused on organizations that make significant contributions to the economy, maintain a high level of employment, and actively participate in research and development projects. The survey had 45 inquiries pertaining to general information, sector-specific information, raw materials, resource utilization, and waste production. The assessment questions encompassed a range of areas, including general metrics and uses, workforce excellence and employment, resource choice, water and energy usage and control, wastewater and solid waste control, waste gas control, and research and development, innovation, and productivity investigations.

Table 1. Summary of the Annex-I, survey report

Parameter	Findings
Waste	1. Most participants had knowledge regarding the specific type of waste that is produced inside their respective companies. 2. A substantial proportion (59.1%) of participants possess awareness regarding the monthly expenses associated with waste removal, storage, and treatment in their respective businesses. 3. A significant majority (72.7%) of participants indicated that both product and waste storage locations are safeguarded against external influences. 4. A minority (9.1%) of participants reported that storage facilities lack protection. 5. A fraction (18.2%) of participants expressed no discernible viewpoint or knowledge on the posed inquiries.
Water and Wastewater	1. 68.2% of individuals possess knowledge regarding their monthly water consumption. 2. 27.3% of individuals lack awareness of their monthly water usage. 3. 4.5% of individuals are completely unaware of their monthly water consumption. 4. 27.3% of individuals are well-informed about maintenance, cleaning, and sludge disposal procedures if they possess their own treatment facility. 5. 45.4% of individuals lack information regarding maintenance, cleaning, and sludge disposal for their personal treatment facility. 6. 27.3% of individuals possess knowledge about maintenance, cleaning, and sludge disposal for their personal treatment facility. 7. Most respondents answered "no" to both questions.
Energy	1. Approximately 77.3% of the participants are aware of the exact amount of energy they consume monthly. 2. 13.6% of participants are unaware of their monthly energy consumption. 3. According to the survey, a significant majority of participants, specifically 86.4%, hold the belief that the walls are not enclosed and are adorned with various colors. 4. 13.6% of participants hold the belief that the walls are not open and adorned with colors. 5. Approximately 59.1% of the participants either currently utilize or have intentions to install a motion sensor lighting system. 6. A total of 27.3% of the participants either do not use or have no intention of installing a motion sensor lighting system. 7. A total of 13.6% of the interviewees expressed uncertainty over the utilization or installation of a motion sensor lighting system.
Emission	1. Most participants, namely 59.1%, were aware of the origins of both direct and indirect emissions that affect water, soil, and air within their organization. 2. Out of the participants, 18.2% responded negatively when asked if they were aware of the sources of emissions. 3. A total of 22.7% of participants expressed neutrality towards the issue. 4. Half of the participants expressed interest in the categorization and volume of emissions. 5. A total of 31.8% of participants exhibited a lack of awareness regarding the physical and chemical properties, as well as the amount, of emissions. 6. 18.2% of participants expressed neutrality towards the subject. 7. A total of 36.4% of the participants possessed an appropriate outlet system and monitoring equipment to regulate the release of air pollution from the boiler room. 8. 36.4% of participants lacked an appropriate infrastructure for an outlet system or monitoring equipment. 9. 27.2% of participants expressed neutrality towards the subject.

In the study assessed and visually displayed the responses provided by the businesses based in the provinces of Amasya, Corum, Samsun, and Tokat.

Table 2 illustrates the prevalence and viability of key criteria throughout several provinces. Samsun has the biggest proportion of enterprises, accounting for 42.8% of the total. Amasya follows with 28.6% and Corum with 14.3%. With a workforce and employment ratio of 37.3%,

Samsun leads Corum by 31.4%. With a rate of 34.5%, Amasya has the highest feasibility for selecting, using, and managing the raw materials, while Tokat comes in second with a rate of 26.4%. Corum comes in second with 18.2% of water management applications, while Samsun has 36.4%. Like this, Samsun has the highest percentage of energy consumption and management applications 37.2% with Corum coming in second at 14.7%. Samsun has the greatest proportion of wastewater management with 38.7%, while Corum follows with 12.9%. Samsun has the biggest proportion of solid waste handling with 36.4%, while Corum follows with 12.1%. Regarding waste gas management, Samsun has the biggest proportion, accounting for 35.5%, while Corum follows closely with 15.4%.

Figure 2 illustrates the resource efficiency potential of the TR83 region, focusing on the specific regions of Amasya, Corum, Samsun, and Tokat. The data offers information on several elements that contribute to resource efficiency in these locations. Amasya has a significant potential of 36% in terms of technological levels, whereas Corum demonstrates a comparatively lower potential of 16% for implementing these technologies. Amasya and Samsun have higher employment rates, with Amasya at 36% and Samsun at 29%. Regarding industrial symbiosis relations, Amasya and Corum each had a 50% share, while Tokat and Samsun both had a 50% share. Interestingly, Tokat had a significant and astounding 33% share of industrial symbiosis ties, which is comparatively higher than other indicators. Amasya and Samsun provided a more favorable atmosphere inside the innovation ecosystem compared to the other two.

In Figure 3, it illustrates the sequential resource efficiency financing process that industries in the TR83 area of Türkiye might use. The figure is partitioned into four distinct portions, each corresponding to a separate geographical region: Amasya, Corum, Samsun, and Tokat. The figure provides data on the levels of technology, the job market, the relationships of industrial symbiosis, and the innovation ecosystem in each region. The percentages for each aspect are further supplied, offering a distinct picture of the resource efficiency potential in these areas. To achieve resource efficiency, it is necessary to have a thorough grasp of the possible advantages and tactics for putting it into practice. The TR83 region acknowledges the importance of cooperation and assistance in assisting enterprises in efficiently implementing resource efficiency.

Table 2. Summary of Annex-II, survey report

Parameters	Amasya (%)	Corum (%)	Samsun (%)	Tokat (%)
Distributions of Businesses	28.6	14.3	42.8	14.3
Distribution of Workforce and Employment	37.3	13.7	31.4	17.6
Feasibility of Raw Material Selection, Use and Management	34.5	14.6	34.5	26.4
Applicability of Water Management	36.4	18.2	30.9	14.5
Energy Consumption and Management Applicability	37.8	14.7	32.8	14.7
Wastewater Management	38.7	12.9	32.2	16.2
Solid Waste Management	36.4	12.1	33.7	18.2
Waste Gas Management	35.5	15.4	33.1	16
R&D, Innovation and Efficiency Studies	31.3	16.8	37.7	14.2

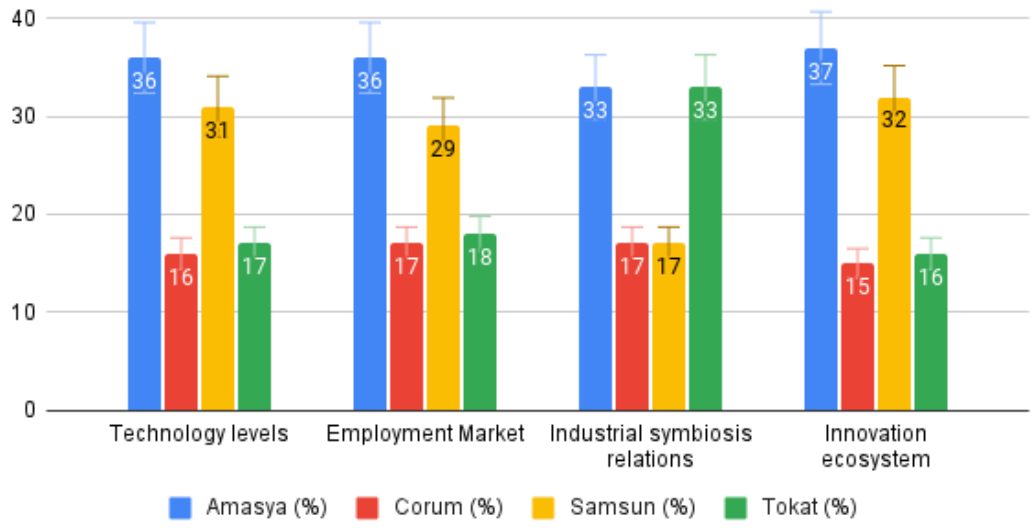

Figure 2. Resource efficiency potential of the TR83 region Black Sea in Türkiye.

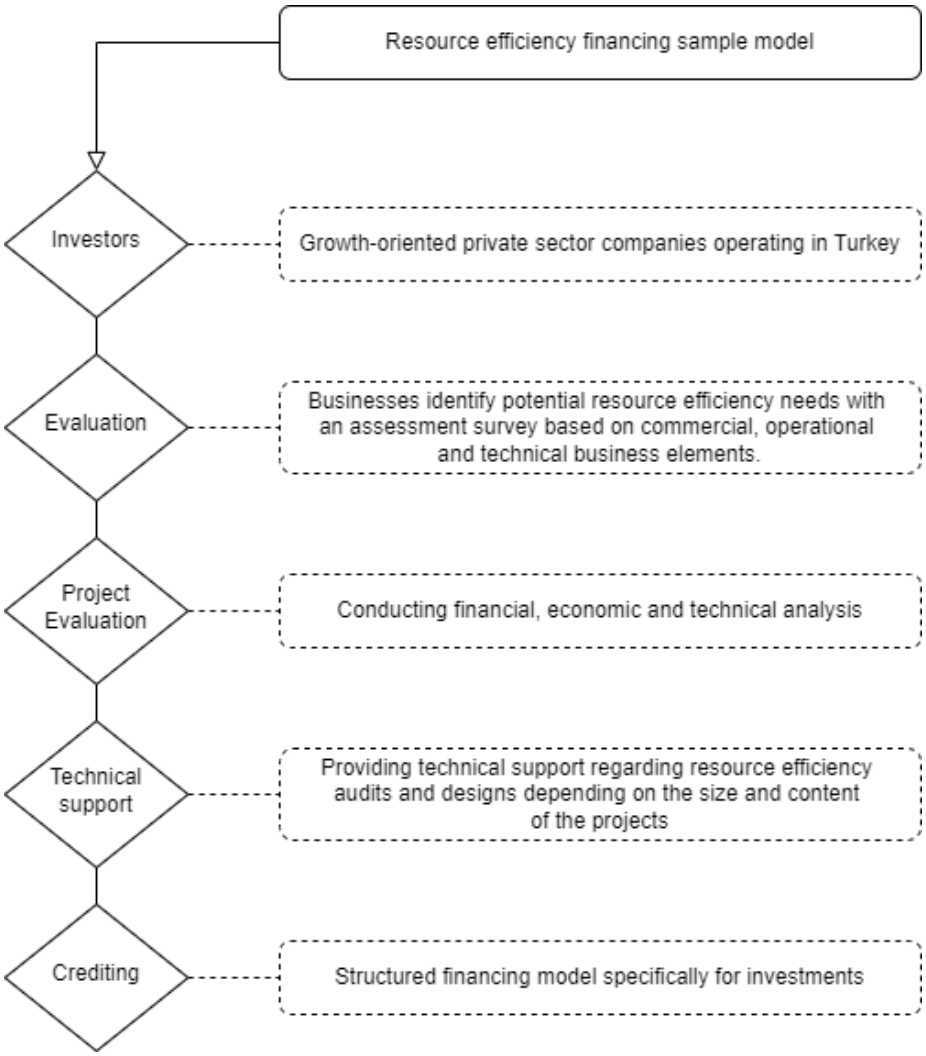

Figure 3. Resource efficiency financing sample model for TR83 region Black Sea in Türkiye.

By fulfilling these requirements, companies can achieve cost reductions, higher environmental sustainability, increased competitiveness, and a range of other advantages. Among the nine indicators, Samsun and Amasya exhibit superior performance compared to Tokat and Corum. Hence, to enhance the present situation in Tokat and Corum, they might emulate the practices of Samsun and Amasya and establish a partnership with their respective local industrial authorities. In summary, the resource efficiency assessment study of the TR83 region emphasizes the significance of implementing resource-efficient practices in the industrial sector. It highlights the capacity of enterprises to attain economic prosperity while also safeguarding the environment and fostering sustainable development. By implementing strategic planning, providing education, and fostering collaboration, the area can establish a production environment that is both more efficient and sustainable.

3.1. SWOT Analysis

This study provides a brief overview of the sensitivities and conditions related to waste management, water and wastewater management, energy use and emission awareness (Table 3). The information provided covers container use, segregation processes, transformations of hazardous waste, storage conditions for both products and waste materials, impacts of water consumption, impacts of energy consumption and sensitivity to emissions. The issues that attracted our attention in this study are summarized in Table 4.

The data analysis uncovers discrepancies in average values pertaining to several facets of waste management and sensitivity in TR83 region (Ardali, 2020). These discrepancies reflect disparities in customs and sensitivities among urban areas. Areas requiring enhancement encompass waste management, utilization of raw materials, methodologies for product packaging, utilization of equipment, prevention and cleansing of chemical waste, provision of an appropriate working environment for staff, and storage conditions for both products and waste. There is potential for improvement in sensitivities to emissions. Still, the data shows that scenarios for reducing waste and reusing it, breaking down and changing the condition of hazardous wastes, water consumption sensitivities, and energy consumption sensitivities have higher average values. This suggests that good practices should be used in these areas.

Table 3. Summary of SWOT analysis in TR83 region in the Black Sea in Türkiye

Strengths	• The urban staging plan exhibits a favorable combination of universities, natural resources, and economic capability. • Authority and impact on decision-making • A city located on a port that connects with Central Anatolia • Policies that promote the relationship between universities and industries • The presence of a trained workforce that is eager to work in the region • Adoption of policies that promote sustainable development • Active involvement in research and plans related to resource efficiency
Weakness	• Inadequate sample size and unclear source • Ambiguous techniques and legislation • Insufficient collaboration and lack of a standardized technique for comparison • Limited accessibility to resource efficiency tools • Insufficient knowledge and absence of technological adaptability in optimizing resource efficiency. • Lack of meaningful standards for improving resource efficiency • Slow implementation of legislative measures and political reform • Disparity in the assessment of resource efficiency and the comparison of outcomes • The lack of promptness in decision-making procedures at the national level
Opportunities	• Gathering and organizing data; constructing and enhancing databases • Legislation and governmental tactics • Potential for investment • Facilitating cooperation between institutions and businesses • Enhancing recognition of respective capabilities • Embracing and advocating for the adoption of change and the implementation of the circular economy. • Conducting training sessions for newly hired individuals in the field of KV vehicle development • Enlisting the participation of local governments • Undertaking research to foster cooperation with nearby universities; optimizing the use of incentive possibilities • Increasing acknowledgment of sustainable economic development and the circular economy
Threats	• Expensive operations without incentives or strategic assistance • Limited influence of small and medium-sized businesses • Reluctance to adapt production methods • Depletion of trained labor • Insufficient investment in human resources • Elaborate procedure for transitioning applications • Insufficient pool of skilled persons • Lack of strategic assistance and uniform procurement terminology • Failure to adhere to universities without supported mechanisms • Limited understanding of the benefits of industrial collaboration • Incapacity to keep a highly qualified workforce

Table 4. Compressional value table in TR83 on different indicators

	Amasya		Corum		Samsun		Tokat	
Parameters (%)	Mean	StdDev	Mean	StdDev	Mean	StdDev	Mean	StdDev
Knowledge level about waste	6.00	-	4.67	2.30	5.21	0.89	5.33	1.15
Knowledge level about raw material usage	5.00	1.41	5.00	1.00	4.29	1.49	3.33	1.15
Waste reduction and reuse situations	17.00	-	14.33	1.76	16.71	3.04	13.00	6.92
Product packaging methods	5.00	1.41	3.67	1.52	4.14	1.29	4.33	0.57
Knowledge level about equipment usage	3.50	2.12	4.67	1.15	4.57	1.39	4.33	1.52
Prevention and cleaning of chemical wastes	5.00	1.41	4.33	1.52	4.93	0.99	4.67	1.15
Suitable working environment for employees	5.00	1.41	5.67	0.57	5.29	0.91	4.67	1.15
Sensitivities shown in container use	4.00	2.82	5.00	1.00	4.64	1.64	4.00	-
Decomposition and changing states of hazardous wastes	5.00	2.82	7.67	1.15	7.14	1.61	8.67	0.57
Product and waste storage situations	6.00	-	5.33	1.15	4.43	1.39	5.33	1.15
Water consumption sensitivities	24.00	2.82	23.33	5.77	22.43	4.34	24.00	7.21
Energy consumption sensitivities	38.50	9.19	40.33	3.05	36.14	5.77	37.67	6.11
Sensitivities to emissions	17.00	5.65	12.33	2.51	13.64	3.91	14.00	6.24

Table 5. TR83 region, according to the field research results, the industries in the region approaches

	Activities has been done (%)	Opportunities can be created (%)
Develops and implements new business and/or production processes,	69	31
Makes significant improvements to existing business and/or production processes and implements them,	71	29
Implemented new marketing/service delivery methods,	59	41
Developing new products/services and introducing them to the market/use,	60	40
Making significant improvements in existing products/services and bringing them to market/use,	69	31
Makes significant changes in the design or packaging of its products. services,	50	50
Conducts studies on environmental protection, energy efficiency, and/or use of renewable energy resources,	53	47
It has been determined that organizational changes have been made to increase corporate efficiency and effectiveness and reduce costs.	69	31

3.2. Environmental, Economic, and Social Benefit Analysis

Integrating sustainable practices in organizations can result in substantial environmental, economic, and social benefits (Chan et al., 2022). Implementing these practices can mitigate pollution, enhance manufacturing efficiency, and enhance an organization's reputation, among other advantages. Nevertheless, the significance of environmental management in manufacturing strategy differs among companies (Crowe and Brennan, 2005). According to Jafari (2017) environmental practices that focus on internal operations and socially sustainable practices have the greatest influence on both environmental and financial performance. The organization's attitude toward understanding and pursuing community requirements, the methodical identification and control of sustainability, and the consideration of staff needs all have an impact on the execution of sustainability initiatives (Fonseca, 2015). Based on an in-depth analysis of the data, this study suggests that the TR83 region may successfully adopt circular economy strategies by carefully adhering to industry-specific procedures. Moreover, by recognizing TR83 as an Economic Potential Zone (Ardali, 2020), the implementation of joint endeavours to adopt circular economy techniques might result in significant advantages. Although several indicators have displayed promising signals due to the adopted measures, it is essential to focus on improving the speed at which the establishment is being carried out, since it is currently below the desired levels. Several chances are waiting to be utilized, given the unexplored potential that exists. By

accelerating the rate of implementation, TR83 can generate several possibilities and promote a more enduring and robust economic environment.

Table 5 presents a concise overview of the activities and possibilities associated with the enhancement and advancement of business in the TR83 region. Based on the findings of the field research, industries in the region have undertaken many initiatives to improve their operations. These activities encompass the creation and execution of novel business and production procedures, substantial enhancements to current procedures, the implementation of innovative marketing and service delivery approaches, the development and introduction of fresh products or services to the market, and substantial modifications to product or service design or packaging. In addition, enterprises in the area have undertaken research on environmental conservation, energy conservation, and the use of sustainable energy sources. Organizational adjustments have been implemented to enhance business efficiency and effectiveness while also decreasing expenses.

According to the World Business Council for Sustainable Development (WBCSD), sustainable production and consumption contribute to environmental quality through the efficient production and use of natural resources, waste minimization, and optimization of products and services. The sustainable production approach is a production strategy that not only provides environmental benefits but also economic returns. The widespread adoption of resource efficiency practices, which can be considered a prerequisite for sustainable production, is highly important and effective. However, when resource efficiency practices remain within the boundaries of a firm, these practices can only enhance environmental performance to a certain extent. Therefore, to achieve further gains, a comprehensive regional approach that goes beyond the boundaries of individual firms and often facilitates inter-company and inter-sectoral collaboration is crucial for amplifying the multiplier effect of resource efficiency practices. Efficient and sustainable use of raw materials, energy and water, reducing the impact on the environment and increasing competitiveness by producing more value by using fewer inputs, will contribute to the sustainability of production and therefore the economy, awareness has been raised among the regional producers. Today, when the importance of resource efficiency has become clearer, the development and effective implementation of policies, strategies and actions in this field has emerged as a necessity in Türkiye. Investments in resource efficiency practices enhance the environmental performance of industrial organizations, positively influencing their economic performance and corporate prestige, contributing to growth, and increasing productivity. Resource efficiency will contribute greatly not only to sustainability and environmental improvement, but also economically.

Table 6. Proposals for enhancing resource efficiency in the TR83 region based on the discovered results

Strategic consumption markets allow for the use of products produced with resource efficiency can be directed.
Requests from public institutions should be supportive of resource efficiency must be provided.
Awareness should be raised - training should be provided. Welding-related communication and training process It should become a part of daily life.
Awareness campaigns should be carried out.
Explain the requirements and benefits of resource efficiency with best practice examples
Visualization is necessary to initiate learning processes. Entry of products into the market should be supported.
In accordance with the eco-design directive, the standards have improved the average mass market products. It should be directed towards resource efficiency.
New region-specific resource efficiency requirements should be included.
A study on appropriate clustering in Organized Industrial Zones and industries. Integrated programs should be planned in these areas.
Resource efficiency scales should be developed in industries and existing scales should be adapted according to industry branches.
For resource efficiency, the current burden of the industry will be alleviated through support, incentives and grants.
New production-consumption approaches should be adopted.
Resource efficiency will be effective in solving existing problems in the TR83 region.

4. Conclusion

In conclusion, the study identified a wide range of strategies that can be implemented to increase resource efficiency in the TR83 region. These initiatives span many sectors and methodologies. The proposed measures, which include promoting the use of resource-efficient goods, establishing environmentally friendly design standards, and implementing comprehensive programs in industrial areas, highlight the complex and diverse aspects of resource efficiency. This research highlights the possible circular economic and environmental advantages of investing in resource efficiency, particularly in optimizing the use of natural resources such as raw materials, electricity and water. Although there are obstacles and hurdles, the article puts a positive perspective on the joint efforts of the European Union

and Türkiye to gradually adopt resource efficiency programs. Solving the current problems and utilizing the significant potential for resource-efficient practices in the TR83 region will create a positive chance for economic growth and making significant contributions to the protection of the global climate. While the concept of resource efficiency and circular economy in the region is associated only with energy, awareness of the need to manage raw material, water, energy and chemical inputs has been created. In addition, the importance of waste, wastewater and waste emission control as outputs was also emphasized. By providing a significant data accumulation for green production, it has become important in determining the road map for the future. In summary, the article supports the idea of a deliberate and coordinated effort to achieve a future that is both sustainable and efficient in the use of resources in the TR83 region. With the approach of "doing more using less resources" to achieve the goal of sustainable production in our region; The aim is to raise awareness about the potential economic gains as well as the environmental benefits that resource efficiency practices will provide to institutions and companies, to encourage industrial enterprises in the region to use resources efficiently by creating good practice examples, and to disseminate industrial symbiosis practices. To implement green industrial practices in industries in the region.

Author Contributions

The percentage of the author(s) contributions is presented below. All authors reviewed and approved the final version of the manuscript.

	M.S.H.	N.A.A.J.	B.A.E.	Y.A.
C	25	25	20	30
D	25		25	50
S			30	70
DCP		50	50	
DAI	25	25	25	25
L	70	30		
W	50	30	10	10
CR	30	10	10	50
SR	100			
PM			30	70
FA			30	70

C=Concept, D= design, S= supervision, DCP= data collection and/or processing, DAI= data analysis and/or interpretation, L= literature search, W= writing, CR= critical review, SR= submission and revision, PM= project management, FA= funding acquisition.

Conflict of Interest

The authors declared that there is no conflict of interest.

Ethical Consideration

Ethics committee approval was not required for this study because of there was no study on animals or humans.

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