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Spatial Analysis of Snow Cover Distribution in Maysan Province

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Abstract

This research addresses the geographical analysis of the distribution of ice factories in Maysan Province. These factories are distributed across the province, and this industry holds significant importance for the population, especially during summer, as Maysan is one of the hottest regions in the country. It experiences high temperatures in summer, making ice essential for numerous daily and industrial activities, such as cooling and preserving food and beverages. Thus, the distribution of ice factories in the province is vital to meet this growing demand.
This study aims to highlight the geographical distribution of ice factories in Maysan Province and understand the relationship between geographical factors and their distribution. Through spatial data analysis and geographical investigation, the study provides a comprehensive overview of areas lacking ice factories and identifies opportunities to improve distribution in line with increasing demand. The study is organized into three chapters and sections: Chapter One (Section 1): The concept of ice production. (Section 2): Historical development stages of ice factories in Maysan Province. Chapter Two (Section 1): Factors influencing the localization of ice factories in Maysan. (Section 2): Current status of ice factories in Maysan Province. Chapter Three: Geographical distribution of ice factories in Maysan Province. The study revealed disparities in ice factory distribution between urban and rural areas of Maysan Province. Urban areas suffer from factory overconcentration, elevated environmental pollution, and noise, while rural areas face scarcity. of such facilities, forcing residents to import ice from other regions. The study also highlighted operational challenges, such as power outages and machinery maintenance neglect, which disrupt production during peak summer demand and threaten the stability of local supply networks. Conversely, it emphasized the social role of rural ice factories in reducing unemployment and improving incomes, despite limited expansion due to weak government investment and infrastructure. The study recommends adopting an investment map based on balanced factory distribution (spatial equity), utilizing modern technologies and renewable energy to reduce costs, enhancing environmental oversight, and involving the private sector in rural development. In conclusion, this study provides policymakers with a framework to improve Maysan's ice industry, ensuring sustainable development and meeting local needs despite climatic and economic challenges.

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I. Introduction

Amid rising temperatures and increasing demand for ice in Maysan Province, ice factories have become vital infrastructure components, playing a crucial role in meeting daily population needs and economic activities. Given the uneven geographical distribution of these factories, analytical research is essential to understand influencing factors such as raw material availability, population density, market presence, and geographical coverage adequacy. This research aims to analyze the spatial distribution of ice factories in Maysan using Geographic Information Systems (GIS) and statistical methods, identifying current distribution patterns and their alignment with actual demand. The study further evaluates geographical and economic factors affecting site selection, providing recommendations for future distribution optimization. The significance of this study lies in supporting provincial development planning, as its findings may enhance economic efficiency, environmental sustainability, and equitable community service delivery.

II. Research Objective

The study aims to examine ice factories, analyze factors influencing their localization, and evaluate both their operational status and geographical distribution in Maysan Province.

II. Research Problem

The research problem centers on: Do industrial localization factors influence the establishment and development of ice factories?
Does the distribution/concentration of ice factories reflect these localization factors?

IV. Research Hypotheses

Despite ice production being an industrial activity meeting population needs (as part of food industries), the study assumes:

1. Despite available localization factors, production fails to meet consumer market demand and exhibits seasonal operation.
2. Despite localization feasibility, many provincial areas lack such facilities.
3. Most factories use obsolete production methods and disregard environmental regulations.

V. Methodology

The research employs multiple approaches: descriptive, systems-based, geographical, and environmental methodologies for scientific analysis of ice factories' geographical distribution in Maysan.

VI. Spatiotemporal Scope of the Study

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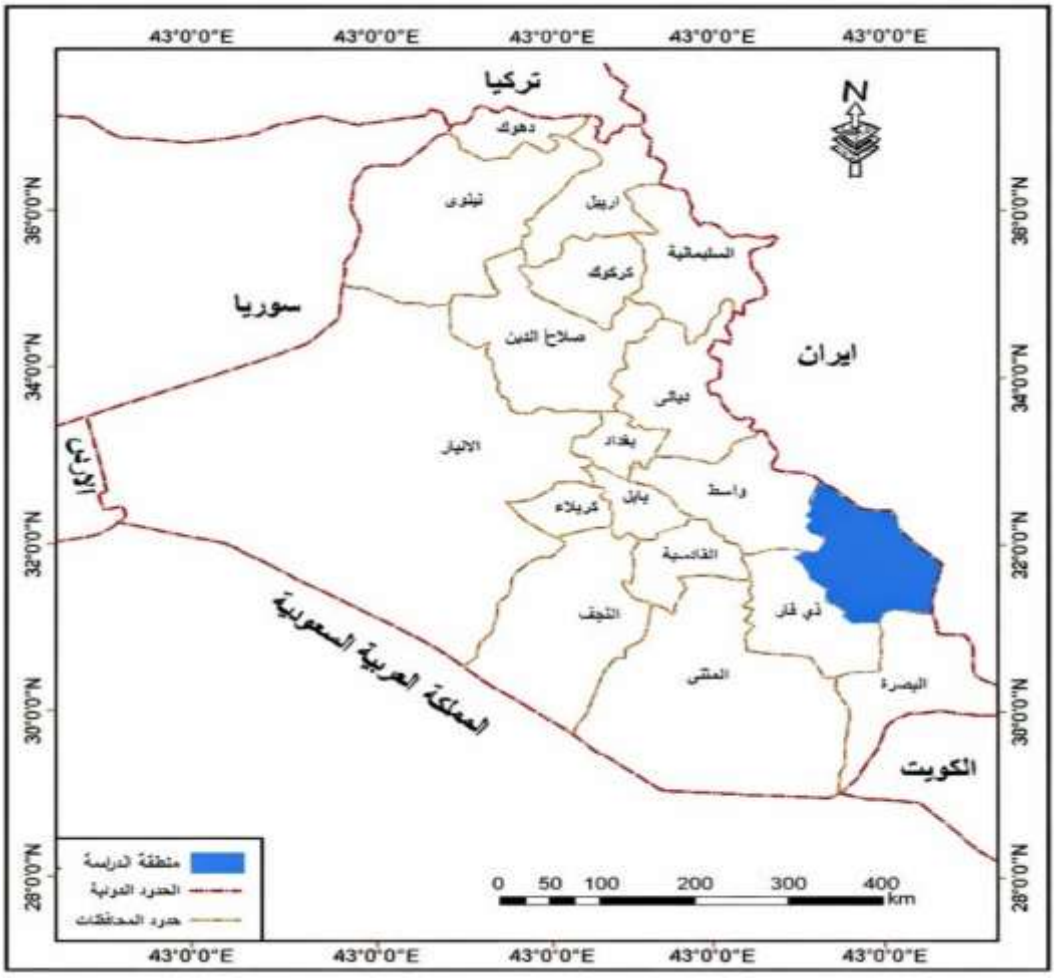
The spatiotemporal scope is represented by the administrative boundaries of Maysan Province, located in southeastern Iraq, which extends in a northeast-southwest direction between latitudes 30°46'–47°45'N and longitudes 45°32'–47°15'E, as shown in Map (1). Administratively, it is bordered to the north by Wasit Province and to the south by Basra Province, while to the east it is bordered by the Islamic Republic of Iran, and to the west by Dhi Qar Province, as shown in Map (2). The province consists of six districts: Ali Al-Gharbi, Al-Amarah, Al-Kahlaa, Qalat Saleh, Al-Maimouna, and Al-Majar Al-Kabir. The area of Maysan Province is 16.378 km², constituting 3.7% of the total area of Iraq. Regarding the temporal scope of the study, it was defined as the period from before 1915 until 2023.

Map No. (1):
Location of Maysan Governorate within Iraq and its administrative units



Source: Republic of Iraq, General Directorate of Survey, Map Production Department, Administrative Map of Iraq, scale 1:1,000,000, Baghdad, 2024.

Chapter One:

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Ice Industry - Concept, Importance, Characteristics, and Historical Development

The ice industry is an important service industry that emerged due to the need to preserve food and beverages at low temperatures, especially in regions with hot climates (Al-Obeidi, 2018). This industry has contributed to meeting the demands of human daily life, as its products are used in various fields such as fishing, transportation, industry, and commercial refrigeration (Al-Saadi, 2020). The importance of the ice industry is highlighted by its role in supporting economic and service activities, in addition to being an indicator of the level of industrial and service development in different regions (Hameed, 2019). This chapter includes two main sections: the first section addresses the concept, importance, and characteristics of the ice industry, while the second section discusses the historical stages of the development of the ice industry up to its current form.

First: The Scientific and Practical Concept of Ice Manufacturing

The scientific definition of the ice manufacturing industry: It is the process of converting water from its liquid state to its solid state (ice) by extracting thermal energy from it using thermodynamic refrigeration cycles, whereby the water temperature drops below its freezing point under carefully controlled conditions (American Society of Heating, 2022) . The Ice Industry: It is considered a seasonal industry that works to transform water from a liquid state to a solid state after undergoing several stages in its production processes, resulting in rectangular blocks. This industry thrives in the summer and declines or stops in the winter. It is significantly affected, and demand for its products decreases, especially with the continuous availability of electricity and the use of refrigerators, freezers, and water coolers. Conversely, demand increases significantly, particularly during days of high temperatures in the summer accompanied by power outages and the stoppage of freezing and cooling machines, prompting residents to buy the products of this industry to alleviate the impact of intense heat (Al-Abadi, 2022).

Second: The Economic and Social Importance of the Ice Industry

Thanks to its multiple uses, the ice industry is a vital industry that plays a significant role in our daily lives duSe to its great importance in numerous fields:

1. **Food Preservation:** It keeps food and beverages cold and fresh. It also contributes to preserving dairy products, meat, and fish at appropriate temperatures to maintain their quality and prevent spoilage. It is also used for kneading bread in hot regions.
2. **Agricultural Sector:** It preserves agricultural crops from spoilage during storage and transport.

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3. **Medical Sector:** Ice is used to preserve important medicines and medical materials that require refrigeration, such as vaccines.
4. **Supporting Fishing:** Ice is used to preserve fish and marine products, helping to maintain their quality during transport and distribution.
5. **Social Events and Activities:** Many people in Maysan Governorate rely on ice for social occasions and events to provide cold beverages and fresh food. It is also used at the university during the final exam period to cool water and provide it for students.

Third: The Technical and Economic Characteristics of the Ice Industry

The ice industry in Maysan Governorate is influenced by several characteristics related to the local environment, infrastructure, and economic challenges, the most important of which are:

1. **High Demand:** Due to high temperatures in the study area, there is significant demand for ice, especially in the summer and for several months longer than the cold months. It is used for cooling and keeping food and beverages cold.
2. **Raw Materials:** Ice production relies on the availability of pure water and electricity. In some areas, some factories may face difficulties in obtaining sources of pure and sustainable water, as well as fluctuations in electricity availability.
3. **Cost and Economy:** The cost of ice production depends on electricity and water prices, as well as maintenance costs and equipment import. Political and economic conditions may affect these factors.
4. **Energy and Electricity:** The ice industry faces significant challenges regarding the stability and availability of electricity. Frequent power outages can disrupt production and lead to losses. Therefore, we observe that the electricity crisis and prolonged outages have led residents to buy ice due to the stoppage of household refrigerators and their inability to meet the daily ice needs of Maysani families.
5. **Environmental Challenges:** Iraq faces environmental challenges like water scarcity, which affects the ice industry and increases the importance of using water efficiently and finding sustainable water sources.
6. **Maintenance and Technical Support**: Ice manufacturing equipment requires regular maintenance and technical support. The lack of local expertise in this field may pose a challenge to maintaining equipment efficiently.

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7. **Distribution and Transport**: Effective transport and proper storage of ice are crucial elements in ensuring ice reaches consumers with high quality, especially in hot weather where ice melts quickly.
8. **Development and Modernization**: There is a continuous need to modernize and develop the ice industry in Iraq in general, and Maysan Governorate in particular, by adopting new technologies and improving production efficiency to ensure meeting the increasing demand and improving product quality (Rahima, 2024).

Fourth: The Historical Development Stages of the Ice Industry in Misan Province

Ice was uncommon in Iraq before the 20th century. This industry emerged modestly during the late Ottoman period, with production limited to a single factory that distributed small quantities at high prices. Consequently, only a small segment of the population could afford it, primarily using it during Ramadan to alleviate the thirst of fasting individuals. By the early 1920s, the industry began gradual expansion. In Iraq, particularly in Maysan Province, ice-block manufacturing stands as one of the oldest traditional industries known to the local community. To trace its origins, it should be noted that humanity historically employed primitive ice-making methods relying on chemical reactions using salts such as ammonium nitrate (nitrates), ammonium chloride (ammonia), and sodium carbonate. These compounds absorbed heat from water to form ice blocks. In the city of Amarah, the establishment of the first ice factory dates back to World War I, founded by Haj Zayer Al-Rashid as part of contemporary efforts to modernize local industries. This factory played a pivotal role in meeting the growing needs of residents—both for household use and social occasions—laying the groundwork for the industry's subsequent development.

Stages of Ice Factory Development

1. Establishment Phase (1914–1958)

Maysan Province witnessed the emergence of its first ice factories during World War I (1914–1918). These factories relied on primitive fuel-oil (black oil) technologies to power their machinery, producing limited quantities of ice that nonetheless sufficed for local needs at the time. This nascent industry operated within an exceptionally complex economic and political context shaped by WWI's aftermath – including logistical disruptions from road blockages, reduced transportation, and consequent shortages of essential raw materials like fuel and water, all of which hindered production continuity. Economically, ice factories faced partial or complete shutdown risks due to resource scarcity and declining investments. Socially, challenges manifested through deteriorating living conditions for local workers and communities, as government efforts prioritized military needs over civilian welfare.

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Technologically, the period saw minimal innovation, with stagnation in production methods as efforts focused solely on meeting immediate demands. Despite scarce records and damaged infrastructure obscuring precise details of development between 1914–1938, evidence indicates this era constituted a critical phase for local industry. All sectors – including ice production – were impacted by prolonged political and economic instability extending beyond the war.

1922 stands as the definitive starting point for ice factory establishment in Maysan, specifically in Amarah city center, to meet population needs for food and beverage cooling. . (Madhloum, 2024) .

2. Phase of Relative Stability (1935–1958)

The ice industry in Maysan Province underwent gradual development through successive stages, beginning in the third decade of the 20th century (1930–1940) with the spread of simple ice factories in the province's major cities. This expansion was driven by increasing demand due to steady population growth—a key development challenge in developing nations (Hussein, 2017) .In the following decade (1940–1950), more advanced cooling technologies, such as electric refrigeration equipment, were introduced, significantly improving production efficiency and increasing output. This marked a qualitative leap compared to the previous phase. By the early 1950s, the Al-Azizawi Factory in Amarah's industrial district emerged as one of the leading facilities, playing a pivotal role in supplying ice to residents during difficult times. The factory remained operational for decades after major upgrades, including expanded facilities and modernization with high-speed, energy-efficient electric refrigeration technology. However, it ceased operations in 2012 after decades of dominance, likely due to a combination of economic and technical factors, including rising operational costs amid frequent power outages, aging infrastructure despite modernization attempts, and declining government support for local industries. Additionally, the unstable security conditions during that period disrupted many industrial facilities in the province, including this factor (Hassan M. R., 2024) .

The period (1940–1958) was termed the "Phase of Relative Stability" due to its progress in industrial infrastructure, supported by post-World War II global improvements, which allowed Iraq to import advanced electric refrigeration technology. (Al-Ali, 2015) . This development was evident in the expansion of factories in urban centers like Amarah and Al-Majar Al-Kabir, where their numbers increased from 3 in 1940 to 12 by 1960 (Municipality, 1970–1980). However, growth remained limited due to structural obstacles, including unreliable electricity grids, the state's prioritization of agriculture, and rising ice consumption driven by expansion in the health and agricultural sectors. (Hassan L. , 2005). Thus, this phase laid the foundation for the local industry, though it was not without challenges that later led to periods of stagnation.

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3. Stagnation Phase (1959-2003)

The ice production sector in Maysan Province witnessed a prolonged period of relative stagnation extending from 1959 to 2003, marked by profound political and economic transformations that negatively impacted the sector's development. This phase began with the declaration of the republican system in Iraq in 1958, which brought partial nationalization policies for industries, followed by the Iran-Iraq War (1980-1988), then the Second Gulf War (1991) and subsequent international economic sanctions until 2003. During the 1950s and 1960s, despite modernization attempts at some facilities like the Great Amarah Ice Factory (established in the 1950s on Al-Ma'arif Street), capital shortages and unstable government policies prevented industrial expansion, particularly in rural areas. In the 1960s, limited private factories emerged, such as the factory owned by Hajj Jalil Al-Hajj Ibrahim which specialized in fish cooling, but these remained unable to meet village needs. In the early 1970s, the government attempted to develop the sector through international partnerships, such as establishing four advanced factories in 1973 with German assistance in the districts of Al-Maimouna, Al-Salam, Kumait, and Ali Al-Gharbi. However, their subsequent transfer to private ownership through auctions weakened their sustainability. During the 1980s, despite the construction of 12 new factories (including three government-owned facilities built by an Egyptian company in 1984), the impacts of the Iran-Iraq War shifted priorities toward military efforts, hindering infrastructure modernization. (Municipality, 1970-1980). By the 1990s, stagnation worsened with the imposition of international sanctions, which caused shortages of spare parts and increased operational costs, leading to neglected maintenance and declining production. However, this period saw unplanned growth of small private factories, such as those in Al-Majar Al-Kabir and Qalat Salih, to support populations displaced by the marsh drainage projects. These relied on primitive technologies and widened the service gap between urban and rural areas (Al-Yasiri, 2024). Throughout this extended phase, the ice industry remained hostage to political conditions, with absent government investment, factories dependent on outdated generators, and most facilities transferred to private ownership without adequate quality control regulations. Despite ice's vital role in crisis response, the lack of strategic vision prevented its transformation into a sustainable developmental resource, leaving it as a witness to complex historical transitions between war and peace, prosperity and collapse.

4. Recovery and Expansion Phase (2004–2024)

The ice industry in Maysan Province underwent significant transformation after 2003 following the regime change which brought economic openness and increased private investment though structural challenges persisted including chronic electricity shortages and rising temperatures that boosted ice demand This phase began with gradual security and economic improvements allowing new factories to open and old ones to modernize using advanced technologies like electric compressors that enhanced productivity. During the first

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post-2003 decade (2004-2010) new factories focused mainly on urban areas like Amarah while rural regions continued facing service shortages As the second decade began (2010-2020) sustainability trends emerged through eco-friendly technologies including water recycling systems at facilities like the Advanced Ali Al-Gharbi Plant (2018) equipped with modern machinery considered the province's most efficient However unplanned urban expansion led to factory overcrowding and unfair competition forcing some closures while villages relied on urban centers for ice supplies.

In recent years (2020-2024) most ice factories concentrated in major cities like Amarah while rural areas still suffered severe shortages Despite partial technological upgrades like advanced electric compressors many facilities still used outdated equipment requiring constant maintenance Heavy reliance on private generators due to frequent power outages doubled operational costs Meanwhile haphazard urban factory expansion created oversaturation pushing some to close while villages imported ice from nearby cities Environmental pollution from wastewater discharge remained a key challenge especially without effective industrial waste treatment. Ultimately while showing quantitative growth Maysan's ice industry still needs fair distribution policies investments in sustainable technologies and strict environmental regulations to evolve from crisis response into genuine developmental driver.

Chapter Two
Factors in the Locationalization of the Ice Industry

The study of industrial location (locationalization) is useful in understanding the extent to which the components of an industrial site influence attracting industry to it. The success and establishment of an industry in a specific location indicate the availability of a set of geographical controls and factors that have collectively, albeit in varying proportions, contributed to its localization in that site rather than others. Consequently, these controls are what grant the characteristic of localization to this industry and govern the degree of success in its establishment at such a location (Al-Dulaimi, 2018). Industrial locationalization means choosing a specific milieu or environment for establishing a particular industry or industries. That is, selecting sites and environments that are suitable economically, socially, geographically, and even politically for establishing industrial projects and distributing them across the country's geographical area. The aim is to achieve a national industrial fabric with clear, pre-defined national goals. To realize this, the state, through its specialized agencies, designates areas it wishes to develop, and industrial project owners choose the locations they deem suitable for their projects. Based on the above, a distinction can be made between industrial location (natural/economic) and industrial locationalization (planned/policy-driven) as follows:

Industrial location is a spontaneous process that relies on specific factors working together to attract industry for the purpose of profit. In contrast, industrial locationalization is an intentional process aimed at social welfare and does not necessarily rely entirely on all the

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factors that attract industry (Boukebous, 2014-2015) .The location decisions for ice factories are influenced by a set of dynamic factors whose priority and degree of impact vary according to temporal and spatial circumstances. This determines the required number of factories and their sizes in line with market needs. The most prominent of these factors are:

First: Raw Material

Water is considered the fundamental raw material in ice production, as it constitutes the main component of this industry. The availability and diversity of local raw materials in a country reflect more favorable conditions for industrial development (Abbas, 2018). Maysan Governorate is characterized by an abundance of water sources, particularly from the Tigris River, which is a primary source for supplying factories with the necessary water. These factories resort to using water desalination plants to ensure water quality and reduce the percentage of salts and impurities that may affect the quality of the produced ice. Among the characteristics of the water used in ice production are purity, as the water must be free of impurities to ensure a healthy and transparent product. Another characteristic is desalination; reverse osmosis water purification systems are used, which refers to a physical process for water purification based on the use of a semi-permeable membrane (Ramadan, 2019). To remove excess salts, and Maysan Governorate is one of the provinces that suffers from high water salinity. Also, among the characteristics of water is disinfection, which plays a role in water treatment with disinfectants such as chlorine in specific proportions not exceeding (0.5 mg/L) to ensure it is free from harmful microbes. Among the challenges related to raw materials are fluctuations in water quality. Water quality may be affected by the dry season or environmental pollution, requiring additional treatment. Also, desalination costs, such as using reverse osmosis water purification plants, lead to increased operational costs due to energy consumption and periodic maintenance. In addition, plants rely on electric generators, as frequent power outages force plants to depend on generators, which raises operational costs and affects production stability. There are alternatives for improving water use efficiency, including recycling cooling water: Closed systems can be used to recycle water used for cooling machinery, thus reducing waste. Also, partnership with the oil sector to utilize treated water resulting from oil operations after purification (Jawad, 2024)

Secondly: Capital

Capital is considered the main factor in the sustainability and development of the ice industry in Maysan Province, as this industry faces significant financial challenges. It requires substantial initial investments that may exceed 500 million Iraqi dinars to cover construction and setup costs, due to the large areas required which exceed 1000 square meters, in addition to the costs of modern equipment necessary for advanced cooling technologies. Image No. (1)

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Ice factories in Maysan Province suffer from high ongoing operational costs, which include regular equipment maintenance expenses, importing essential raw materials such as ammonia gas, in addition to heavy reliance on high-capacity electrical generators (350 kilowatts) due to frequent power outages. These factories also face financial challenges represented by the limited availability of bank loans and the absence of sufficient government support, forcing most of them to rely on limited self-financing.

Image No. (1)
The engine used in operating the ice machine

Source: The image was taken on 5/7/2024

Al-Azzawi Factory in Amarah city stands out as a successful model of large factories in the province, boasting a daily production capacity of up to 3,000 ice blocks (Hanoon, 2025). with extensive distribution capabilities across wide areas. It also relies on an alternative fuel system (such as gas oil) as a backup during power outages, enabling it to operate continuously for 24 hours daily. These factories vary in their sizes and production capacities. To ensure the continuity and development of this vital industry, effective government intervention is required through providing soft loans and tax exemptions, alongside encouraging local investments and establishing strategic partnerships with the local oil sector to secure raw materials at appropriate prices.

Basic Factory Requirements

1. **Location and Area:** A location in the city center can be chosen for easy access, providing a large area for factory construction, with the allocation of a large basin measuring (15m x 4m).
2. **Equipment and Machinery:** Providing large electrical generators (350 KVA), and providing electric motors of varying capacities (15 horsepower, 100 horsepower, 150

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horsepower, etc.). Also providing cooling machines and units (6-piston and 4-piston) to increase freezing speed, and providing more than 600 iron molds.

3. **Cooling and Gas Requirements:** This is done by providing ammonia gas (more than 4 cylinders), and installing narrow pipes for transporting ammonia gas.

4. **Workforce:** Employing trained labor (up to 5 workers maximum) with experience in operating ice production lines (Mohammed, 2024) .

5. **Infrastructure and Facilities:** This involves providing a highly efficient electrical power source to operate the plant, installing a reverse osmosis water purification station, providing large-capacity water tanks, in addition to installing a condensate water sprinkler system or condensation systems for cooling Image No.(2).

Image No. (2)

Reverse Osmosis Water Purification Station

Source: The image was taken on 5/7/2024

Third: Labor

Labor is a fundamental element in the production process of the ice industry, as this industry cannot be completed without it, especially with the increasing need for manpower during stages of growth and industrial development. Despite the technical and mechanical progress that has reduced total reliance on labor, its role remains crucial in industrial localization and the operation of complex equipment such as refrigeration systems and electric generators. Furthermore, the population influences the processes and patterns of industrial localization in multiple aspects: they are the workers, they are the consumers, and segments among them provide various services to the factories. Upon them falls the burden of managing production and marketing. Therefore, the success of industrial localization processes requires the presence of a population that serves as the labor force for the industry, as well as a market for its products. The number of workers depends on the size of the population in the area, while the level of competence depends on the degree of technical training of the workers, their skills, the

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available industrial environment for them, and the increase in productivity (Abbas, 2018, p. 6) . Thus, we observe the importance of labor in the ice industry, particularly the technical workforce, through the presence of refrigeration machinery, generators, motors, lifting and lowering equipment, and control and monitoring devices. These require specialists in mechanics and electricity, and thus, technicians constitute 25% of the total workers in this industry (Naeem, 2025).

Fourth: Production

Ice factories in Maysan Province exhibit significant variation in production levels, with a single factory producing over 1,000 ice blocks daily. This output varies according to the production capacity of each factory. The production is distributed across various areas of the province, including the city center, outskirts, and subordinate districts, with significant differences in consumption patterns between these areas. The sector faces a clear geographical disparity in the distribution of factories, as most are concentrated in the city center, while rural areas suffer from a severe shortage of this service. This disparity leads to an imbalance in demand patterns, where consumption decreases in urban areas due to the availability of electricity services, while demand increases in rural areas due to the scarcity of basic services. The prices of ice blocks vary from one factory to another and are influenced by several factors, most importantly the factory's production capacity, the density of factories in the area, the availability of infrastructure such as electricity and roads, in addition to operational and transportation costs. In this context, prices are observed to be lower in urban areas due to the high density of factories and the availability of electricity, while prices are higher in rural areas due to the scarcity of factories and higher transportation costs. The ice production process goes through several essential stages. It begins with using specialized equipment to extract the ice from the freezing tanks, employing trained workers for extraction and handling, organizing distribution operations, and operating machinery 24 hours a day to ensure continuous production, with attention paid to hygiene standards and the quality of the blocks, as shown in Photo No. (3)

Image No. (3)

An ice factory in Maysan Province

Source :The image was taken on 6/7/2024

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The industry faces significant challenges, including geographical disparities in distribution, imbalanced demand patterns between regions, difficulty in financing the establishment of new factories in rural areas, and high operational and transportation costs. On the other hand, there are opportunities to improve the sector by developing distribution networks, supporting investment in rural areas, enhancing production process efficiency, and strengthening infrastructure in remote regions. The development of the ice industry in the province is crucial for achieving food security and improving the quality of life, especially given the harsh climatic conditions and summer temperatures exceeding 50 degrees Celsius. This necessitates the development of innovative solutions to meet the growing needs of citizens across various areas of the province.

Fifth: The Market

The market is one of the most important factors that significantly influences determining the suitable location for industrial facilities. The capacity of the local market to absorb industrial products depends on the level of economic and industrial progress on one hand, and on the population and their purchasing power on the other (Raouf, 2010) . It is considered one of the most important components of industrial development and its advancement. Likewise, the size of the market is a factor in the success of industry, since the market size depends on the population and the level of per capita income (Karim, 2019). The attractiveness of markets for localizing industries is often influenced by the characteristics and nature of the industrial products themselves. Some industries are established near their market outlets to avoid incurring high transportation costs that would weaken their ability to compete in distant markets (Al-Janabi, Industrial Geography, 2013). The market factor is one of the main factors that directly influence the operation of ice production plants in Maysan Province. Ice production and prices are affected by supply and demand factors, operational costs, competition among plants, in addition to climatic and regulatory conditions. Ice plants in Maysan heavily rely on electrical energy for freezing and cooling processes. With frequent power outages and rising operational costs during the summer months, particularly in July and August when temperatures reach high levels, production costs increase, leading to a rise in the price of ice in the local market (Tahseen, 2025) . On the other hand, some cases indicate that some factory owners in Maysan reduce the price of ice or distribute it for free during the Arba'een visitation period of Imam Hussein (peace be upon him), in support of the Hussaini processions and visitors. This reflects a social and humanitarian aspect in the operations of these plants, in addition to the economic dimension Figure . Image No .(4).

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Image No. (4)
An ice factory in the Al-Cahraa Neighborhood, Al-Amarah District Center.

Source: The image was taken on 15/7/2024

Competition among factories within the province also plays a significant role in determining prices. Some factories maintain stable prices despite high demand, to preserve their reputation and consumer trust, while others resort to raising prices, exploiting the increased demand during peak periods and high temperatures. Furthermore, transportation and distribution costs are an additional influential factor. The distance of a factory's location from markets or processions increases distribution costs and affects the final price for the consumer. Through the field study and personal interviews conducted by the researcher with a number of ice factory owners in Maysan Province, it was found that some factories – such as the Stars Ice Factory – maintained stable prices during the Arba'eeniya visit period, despite suffering from power outages and high operating costs. In contrast, other factories raised their prices during periods of high temperatures, particularly in July and August, responding to the increased demand and rising operational expenses (Ali A.-H. S., 2025) .

Sixth: Transportation

Transportation plays an effective role in the process of economic development, as it represents the strong pillar and backbone of economic operations (Al-Shammari, 2016).. Transportation is a vital factor that directly affects the feasibility of the ice industry in Maysan Province, where transport costs represent a fundamental element in determining industrial locations according to economic geography theories (Al-Janabi, Industrial Geography, 2013) . Factories spread across various parts of the province face similar logistical challenges with varying degrees of severity. Factories close to main urban centers and strategic road networks enjoy a clear

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competitive advantage, while factories in remote areas face compounded challenges due to the condition of agricultural and dirt roads and long transport distances. These challenges are exacerbated by several factors, including poor road infrastructure between districts and sub-districts, hot climatic conditions that accelerate ice melting, traffic congestion during religious seasons such as the Arba'een visit, and limited mobile cooling means. This disparity in the efficiency of the transport network within the province directly affects the distribution map of factories and their competitiveness, where field interviews have shown that factories in areas with high population density and better infrastructure enjoy a clear relative advantage, while factories in remote rural areas suffer from high costs and weak competitiveness, creating a developmental gap between the center of the province and its outskirts (Ali Q. M.).

Seventh: Land

The land is one of the natural components that contribute to determining the locations of industrial activities, as the establishment of an industrial project depends on the availability of sufficient land that is suitable in terms of its geological nature and stability, as well as its suitability for the construction of buildings and services related to the production process. The cost of the land and its proximity to transportation networks and public services also influence the feasibility of an industrial site. Therefore, industries are often established on low-cost lands located on the outskirts of cities or within designated industrial zones (Abdul Zahra, 2013). Among the policies that should be adopted for locating projects in specific areas is relying on the implementation of appropriate incentives (positive or negative incentives), such as using tax systems and exemption schemes, lowering or raising land prices, providing facilities in infrastructure projects, offering loans and grants, supporting production, or imposing production fees (Al-Brifkani, 2006) . Image No .(4).

Image No .(4) .

One of the ice factories in Maysan Province

Source: The image was taken on 16/7/2024

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Chapter Three

Geographical Distribution and Economic Analysis of Ice Factories in Maysan Province

This chapter analyzes the reality of ice factories in Maysan Province through two main axes: firstly, the geographical distribution of these factories and their spatial spread patterns between urban and rural areas. Secondly, the economic and operational analysis, which addresses their production capacities, workforce, and operational challenges they face. The analysis relies on field data to paint a realistic picture of these factories' ability to meet the local demand for ice in a province that suffers from high temperatures during most months of the year.

First:The Geographical Distribution of Ice Factories in Maysan Governorate

The industrial activity of ice production plants in Maysan Governorate is distributed unevenly among its districts, with the majority concentrated in the governorate's center, Amara District. This district is characterized by a high population density and a growing demand for this commodity, in addition to its central geographic location, which facilitates transportation and distribution to other areas of the governorate. Table (1) shows that the total number of ice production plants in the governorate reached 24, employing 120 workers. The data indicate a clear disparity among the districts in terms of the number of plants, workforce, and operational efficiency. Amara District ranked first with 8 plants, representing 33.3% of the total plants in the governorate, and employing 40 workers, also accounting for 33.3% of the total workforce. This district serves as the main industrial center due to the concentration of economic and service activities and its high population density, making it the primary hub for the production and distribution of ice. Al-Majar Al-Kabir District came second, with 7 plants (29.2%) and 35 workers (29.2%). It is noteworthy that only 5 of these plants are currently operational, while two have ceased operations, indicating certain technical constraints or seasonal demand fluctuations, which reduce operational efficiency. Qal'at Saleh District ranked third with 4 plants (16.7%) and 20 workers (16.7%), with 3 plants (75% of the district's total) non-operational, reflecting low economic viability and limited local demand for ice. Ali Al-Gharbi District ranked fourth, with 3 plants (12.5%) and 15 workers (12.5%), all of which are operational, indicating stable local demand and suitable conditions for continuous operation. Finally, Al-Maimouna and Al-Kahlaa districts each ranked fifth, with 1 plant per district (4.2%) and 5 workers per plant (4.2%), making them the smallest in terms of production capacity and largely dependent on supplies from the governorate center.

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Table (1)

Number of Ice Factories and Workers in them in Misan Province for the Year 2024

Administrative Unit	Number of Plants	Percentage%	Number of Workers	Percentage%	Status
Al-Amarah District	8	33.3	40	33.3	All are ready for operation
Al-Mujar Al-Kabir District	7	29.2	35	29.2	5 operational, 2 stopped
Qal'at Salih District	4	16.7	20	16.7	1 operational, 3 stopped
Ali Al-Gharbi District	3	12.5	15	12.5	All are ready for operation
Al-Maimounah District	1	4.2	5	4.2	Operational
Tota	**24**	**100**	**120**	**100**	

Source: Misan Statistics Directorate, Industrial Statistics Division, Unpublished Data, 2024.

Table (1)

Number of Ice Factories and Workers in them in Misan Province for the Year 2024

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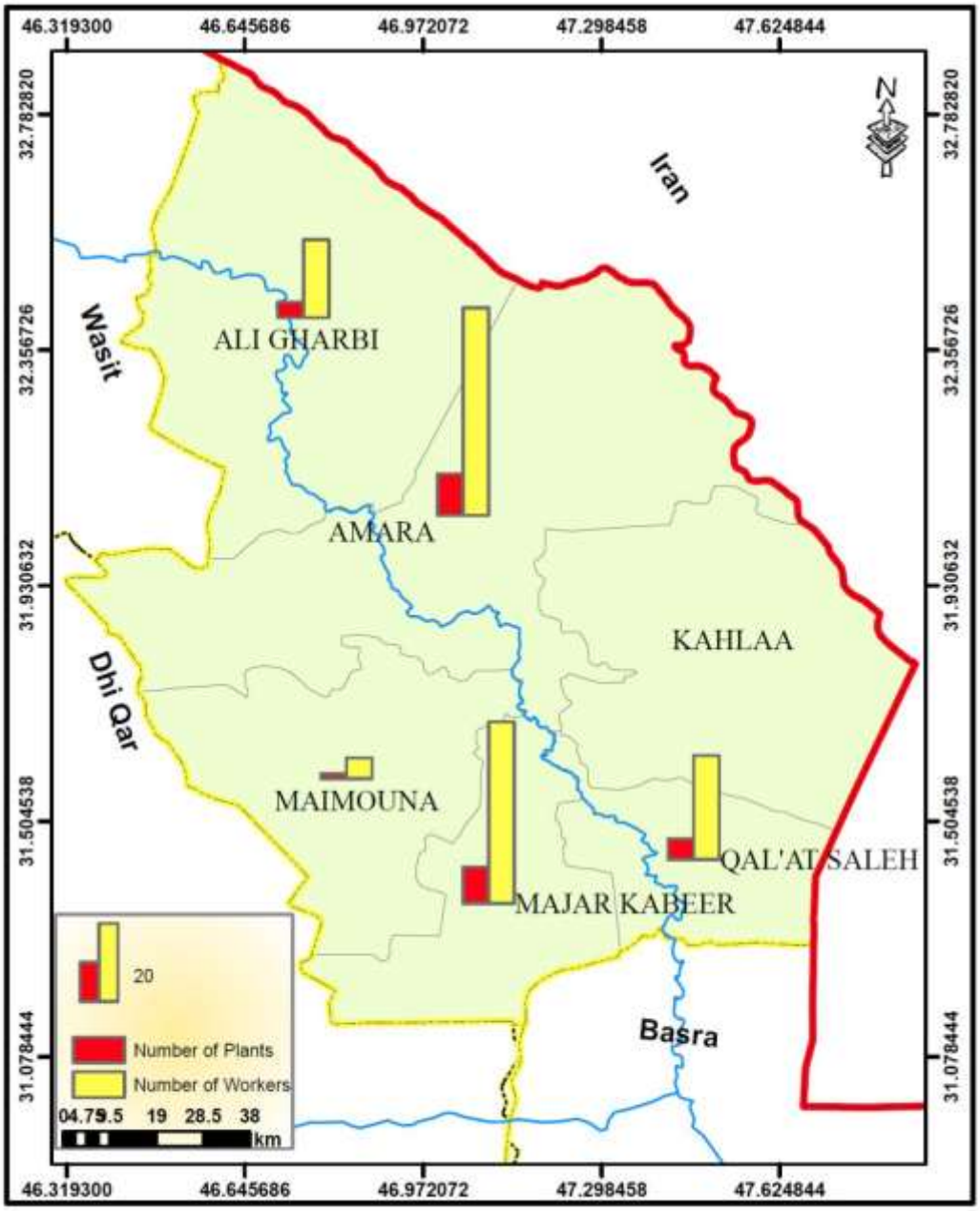

The map was prepared by the researcher based on Table No. (1).

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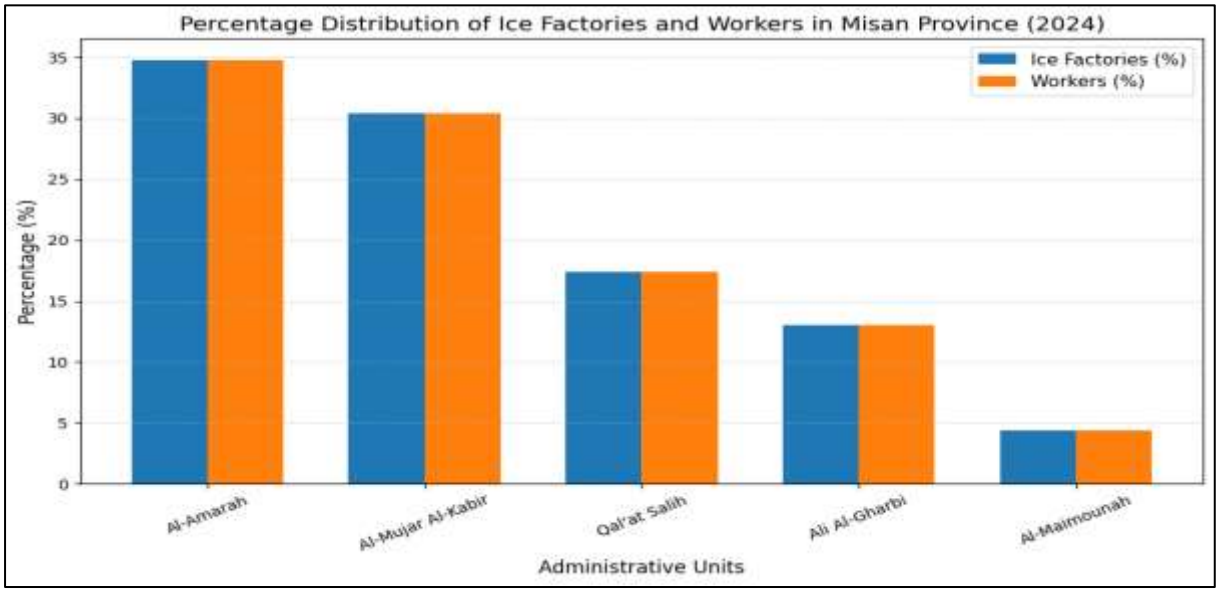
Figure(1)
Number of Ice Factories and Workers in them in Misan Province for the Year 2024



Source: Prepared by the researcher based on the data of Table (1).

Secondly: The Operational and Economic Reality of Ice Factories in Maysan Province

Ice factories in Maysan Province represent a vital industrial sector that directly contributes to meeting local community needs and providing an essential seasonal commodity. The analysis of the operational and economic reality of these factories delves into the study of operational, financial, and production efficiency aspects, which serve as important indicators of their ability to sustain operations and meet market demands (The Arab Center for Economic Studies, 2024) .This analysis aims to evaluate the operational infrastructure of these factories, measure their economic performance level, and identify the challenges they face, thereby contributing to a comprehensive vision about the reality of this industry and its role in the local economy. This is based on the data presented in Table (2), which provides accurate indicators about their production capacities, workforce size, and the nature of their geographical distribution. The analysis of Table (2) reveals the following key indicators:

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Table (2)

Number of Ice Factories and Workers in them in Misan Province for the Year 2024

S.No	Factory Name	Year Established	Capital (IQD)	Project Area (m²)	Number of Workers	Number of Molds
1	Hajji Hassan Ice Factory	1982	650000	850	5	1000
2	Al-Maimouna Ice Factory	1983	700000	2000	5	700
3	Al-Kahlaa Ice Factory	1983	900000	1000	5	850
4	Al-Qalaa Ice Factory	1983	650000	900	4	640
5	Sayid Muhi Ice Factory	1985	800000	900	5	800
6	Mohammed Jassim Ice Factory	1986	750000	900	5	650
7	Kadhim Nylon Factory	1987	670000	800	3	600
8	Ali Al-Gharbi Ice Factory	1990	580000	580	5	480
9	Al-Majidiyah Ice Factory	1990	800000	1000	5	700
10	Al-Wehda Neighborhood Ice Factory	1990	880000	950	4	780
11	Sabah Ice Factory	1991	700000	900	5	600
12	Al-Karrar Ice Factory	1991	950000	1000	5	850
13	Al-Qahira Neighborhood Ice Factory	1992	680000	890	4	550
14	Sayid Hassan Ice Factory	1997	600000	1000	4	500
15	Ali Al-Gharbi 2 Ice Factory	2018	950000	1000	5	950

Source: Ministry of Planning, Central Statistical Organization, Industrial Statistics Department, Unpublished Data, 2024.

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Finally, production capacities and investment disparity: The data reveal a significant disparity in production capacities among ice factories in Maysan Governorate, with Hajji Hassan Factory producing 1,000 ice blocks per day, while the output of some other factories, such as Ali Al-Gharbi Factory, does not exceed 480 blocks per day. This considerable variation in productivity reflects a pronounced imbalance in capital size and investment levels among the factories, which range between 580,000 and 950,000 Iraqi dinars. This indicates that the sector suffers from unequal opportunities and an uneven financial structure, and that low-productivity factories are more vulnerable to economic risks and potential shutdowns due to their limited ability to achieve economies of scale and cope with market fluctuations. These indicators suggest that, although the operational and economic reality of ice factories in Maysan Governorate demonstrates notable activity and vitality in meeting urgent local demand, it remains fragile in many aspects. The sector experiences substantial disparities in production and investment capacities, geographically unbalanced distribution, and serious operational challenges that threaten its sustainability, most notably the electricity crisis. Collectively, these factors negatively affect the sector's efficiency and its ability to meet the growing demand for ice in the governorate in a fair and stable manner Table (2).

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Conclusions:

1. The analysis reveals a clear disparity in the geographical distribution of factories among the districts, with 51.7% of the total factories concentrated in Al-Amara and Al-Majar Al-Kabir districts, while some other districts have few or no factories. This uneven distribution poses an obstacle to achieving equitable economic development and equal employment opportunities across the districts.
2. Al-Amara district represents the main industrial hub in the governorate, hosting 8 out of 15 factories (according to the table), accounting for 25.8% of the total, and employing 40 out of 120 workers, representing 33.3%. This concentration reflects the urban character of the city and highlights the role of high population density and strong demand for industrial products in enhancing economic activity.
3. Factories across the districts face multiple operational challenges, most notably electricity outages affecting all factories (100%), in addition to 6 factories being completely non-operational, representing 40% of the factories in certain districts such as Qalat Saleh. Furthermore, inadequate routine maintenance reduces equipment efficiency and increases operational costs.
4. Factory production exhibits a clear seasonal pattern, with output increasing during the summer months (June, July, August) due to temperatures exceeding 50°C, which raises demand for ice as an alternative means of domestic cooling during frequent power outages.
5. These factories have contributed to providing approximately 120 direct employment opportunities in the districts, helping to reduce unemployment in certain areas. However, limited investment in the sector restricts the potential expansion of its broader economic and social benefits.
6. A significant disparity is observed in the capital and daily production capacities of the factories, with investments ranging between 580,000 and 950,000 Iraqi dinars, and daily production ranging from 480 to 1,000 ice blocks. Hajji Hassan Factory represents the highest production capacity, producing up to 1,000 blocks per day.
7. The data indicate that some factories are completely non-operational, including 75% of the factories in Qalat Saleh district (3 out of 4 factories). This inactivity is attributed to low economic feasibility and high operational costs compared to the limited local demand in these districts.

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Recommendations:

1. **Achieving Geographic Equity Among Districts:** Develop a new investment map that takes into account population density and the specific needs of each district, while encouraging the establishment of new factories in districts with few or no existing facilities, in order to achieve balanced geographic coverage of industrial services.
2. **Technical and Administrative Development of Factories:** Support the modernization of machinery and equipment to enhance production efficiency, while promoting the use of renewable energy sources, such as solar power, to mitigate the electricity crisis and reduce operational costs across the districts.
3. **Strengthening the Institutional Role of the State:** Facilitate state intervention through the establishment of government-operated factories in underdeveloped districts, provide financial support, concessional loans, and tax exemptions to investors, and implement strict standards to ensure quality and safety in all districts.
4. **Improving Infrastructure and Services:** Upgrade roads and transport networks between districts to facilitate the distribution of products and industrial services, and improve electricity supply or provide practical and effective alternatives to ensure continuous factory operations in all districts.

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