International Journal of Sustainable Development and Planning
Vol. 19, No. 5, May, 2024, pp. 1947-1954
Journal homepage: http://iieta.org/journals/ijsdp

How is the Industrial Workers Distributed, Why and What is Their Developmental Role in Saudi Arabia

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https://doi.org/10.18280/ijsdp.190533

Received: 14 March 2024
Revised: 16 April 2024
Accepted: 30 April 2024
Available online: 29 May 2024

Keywords:
spatial distribution, industrial development, industrial workers, workforce, economic development, quality of life

ABSTRACT

Industrial workers in Saudi Arabia constitute about one million workers, which is about 5% of the workforce in general in Saudi Arabia. Therefore, this study dealt with the spatial analysis of industrial workers and its distribution in administrative regions and in various industrial sectors and aimed to analyze the factors affecting its distribution. spatial, and its developmental role in industry, and in the gross domestic product in the Kingdom of Saudi Arabia. The results showed the concentration of industrial workers in the regions: Riyadh, the Eastern Province, and Mecca, and emphasized the role of population, housing, industrial facilities, capital, and the rate of urbanization. And the average income in the distribution of industrial workers. It also showed that there is a statistically significant relationship between the role of industrial workers in industrial development and their contribution to the gross domestic product. The study recommended more attention to study variables such as road lengths and capital. In order to develop industrial workers, as well as direct industrial workers to engage in specific industrial activities, or specific areas; With the aim of achieving comprehensive development and self-sufficiency in industrial products.

1. INTRODUCTION

The industrial sector in developed countries receives great attention for its prominent role in the rest of the economic sectors in the country, as the industrial sector contributes highly effectively to the growth of exports, providing job opportunities, and enhancing added value, in addition to the positive impact on the gross domestic product [1, 2]. In the Kingdom of Saudi Arabia, interest in the industrial sector and its development and development has increased, especially with the launch of the National Strategy for Industry for the Kingdom of Saudi Arabia, which aimed to develop the domestic product and non-oil exports, and focus on 12 sub-sectors with the aim of diversifying the industrial economy, and creating tens of thousands of high-quality, high-value jobs. In addition, developing the national industry is one of the programs of the Kingdom of Saudi Arabia's Vision 2030.

Labor is one of the most important components of the industry and the most prominent variables through which the extent of the industry's localization, development and growth is measured. It is the driving force of industrial activity, which is based on the processes of extracting raw materials, then converting them into primary and final products, and then transporting and marketing them. Thus, industrial workers is one of the crucial aspects of industrial development [3].

The utilization of spatial analysis yields significant efficacy across various domains, particularly in industrial development, driven by several considerations. Foremost among these is the spatial comprehension of diverse phenomena's distribution, offering a clear depiction of areas of concentration and dispersion of the phenomenon across space [4]. This enables the identification of causative factors contributing to its spatial distribution, facilitating informed decision-making by policymakers. Although spatial analysis plays a crucial role in industrial development studies overall, with particular significance for understanding the dynamics of industrial workers, its application remains somewhat constrained. This limitation stems from the predominant focus of most studies, which predominantly approach the subject of industrial workers through purely economic or social lenses [5].

Subsequent to examining the spatial distribution of industrial workers, the study aims to identify the predominant factors influencing this distribution. To achieve this objective, the study will employ various statistical methods capable of elucidating the relationship between the dependent variable (industrial workers) and the explanatory or independent variables (e.g., population, urbanization, income rate, and road network). Among the prominent and precise methodologies utilized is the multiple linear regression model, which gauges the explanatory variables' ability to elucidate and anticipate the dependent variable [6]. Additionally, the Pearson coefficient method, renowned for assessing the strength and direction of inter-variable relationships, will be employed [7]. Incorporating these methodologies, the study endeavors to ascertain the factors impacting industrial workers' distribution

and their ramifications on development in Saudi Arabia.

Drawing upon the preceding discussion, this research endeavor endeavors to scrutinize the spatial distribution of industrial workers across the various regions of Saudi Arabia, leveraging published authoritative data. Subsequently, it seeks to discern the principal factors influencing the dispersion patterns of industrial laborers by synthesizing insights gleaned from antecedent scholarly investigations. This analytical pursuit is facilitated through the employment of established statistical methodologies, notably the multiple linear regression model and the Pearson coefficient. Moreover, the study endeavors to elucidate the contribution of industrial workers to the overarching industrial development trajectory within Saudi Arabia.

2. LITERATURE REVIEW

The examination of spatial distribution stands as a fundamental pillar within the realm of developmental geographical inquiries, facilitating a comprehensive comprehension of how phenomena disseminate across geographical space to depict an accurate portrayal of its reality and extent of dissemination [8]. Subsequently, this understanding serves as a precursor to investigating contributory factors and formulating developmental strategies, whether in economic or social spheres. Spatial distribution analysis holds widespread applicability across various domains, particularly within economic development studies. With the advent and advancement of computer technologies, the utilization of geographic information systems tools has surged, emerging as indispensable within planning and economic development studies, particularly concerning human resources [9, 10]. Notably, spatial analysis assumes a significant role in comprehending the spatial attractors for industrial laborers and evaluating the influence of various factors on their spatial dispersion, thereby furnishing vital insights to authorities and investors [11].

Conversely, spatial distribution analysis remains underutilized within studies pertaining to industrial workers, despite its capacity to provide valuable insights into labor force concentration areas and contributing factors. Most spatial employment studies predominantly explore the relationship between job levels, income, and workers' residential areas or analyze workforce distribution for specific job types [12]. Limited attention is accorded to comprehensive analyses of industrial development encompassing capital, transportation, and labor elements [13, 14].

Nevertheless, insights gleaned from studies focusing on the spatial distribution of industrial labor underscore the significance of this approach in yielding distinctive and crucial findings. For instance, study underscored the pivotal role of spatial analysis in identifying cities with the highest concentration of industrial workers [15], thereby delineating variations in development across regions and elucidating contributing factors. Contrary to prior findings indicating a concentration of industrial workers in major cities [14, 16], Huang's study revealed a concentration of industrial workers in medium-sized cities, challenging prevailing assumptions [17].

Huang et al. [17]'s empirical investigation, employing regression analysis, delineated a departure from the conclusions drawn by Al-Usta [11] regarding the absence of a discernible correlation between market size and the spatial allocation of labor. Huang's findings attributed this deviation to the discernment that the distribution patterns of industrial labor are intricately tied to medium-sized urban centers of industrial significance, characterized by their function as pivotal export nodes rather than mere centers of consumption. Additionally, Huang's inquiry affirmed the nexus between income levels and the spatial dispersion of labor [17], corroborating earlier studies [18]. Concurrently, these investigations underscored the positive association between the distribution of industrial workers and levels of urbanization, a dimension slated for examination in this study alongside other influential factors. The analytical framework will encompass established statistical methodologies commonly employed in similar investigations, notably multiple linear regression and Pearson's coefficient.

Diverse statistical methodologies are employed in studies like the present one, which aims to discern the impact of various factors on the spatial distribution of industrial workers in Saudi Arabia. Rigorous examination of these relationships necessitates the application of statistical tools. Among these, the multiple linear regression model, as exemplified before [19] investigation, and Pearson's coefficient, as demonstrated [20], emerge as viable options for their capacity to elucidate both the magnitude and direction of associations between variables more than other mehtods, such as Moran's [21].

Employing Pearson's coefficient, as utilized in Al-Hurra's [14] inquiry, facilitates a comprehensive exploration of the interactions between social and economic factors—such as population, income rate, urbanization, capital, and road networks—and the distribution of industrial workers. Similarly, regression models, renowned for their efficacy in value estimation and outcome prediction, particularly the multiple linear regression model [22-28] for its precision and minimal errors, serve the purpose of evaluating the influence of industrial workers on industrial development and their contribution to Saudi Arabia's gross domestic product within the framework of this study.

The second aims to assess the capability of the spatial distribution and numerical expansion of industrial employment in estimating industrial development variables, quantifying the contribution of industrial activity to overall output, and forecasting future trends. Regression models, as highlighted [10], are instrumental for such purposes, facilitating the examination of relationships between variables and the extent to which explanatory factors can predict the dependent variable's value, as noted [19]. This assertion is supported by the findings [22], who compared various studies employing regression models and determined that the multiple linear regression model exhibits the highest accuracy and minimal errors. Consequently, this study will rely on the multiple linear regression model to achieve the third objective, which is to assess the influence of industrial workers on industrial development and their contribution to Saudi Arabia's gross domestic product.

3. MATERIALS AND METHODS

To accomplish the study objectives, which entail elucidating the spatial distribution of industrial workers, identifying the factors influencing this distribution, and assessing the developmental impact of industrial workers in Saudi Arabia, a methodological framework combining historical and analytical approaches was adopted.

Furthermore, the study employed various statistical and spatial methods, which will be elaborated upon subsequently. The investigation encompassed all industrial workers in Saudi Arabia, leveraging data sourced from multiple official repositories as delineated in Table 1 below.

Table 1. Datasets used in the study and their sources

Dataset	Source
Saudi Arabia basemap	Saudi Authority for Survey and Geospatial Information
Population Area Urbanization Dwellings Average Income	General Authority for Statistics
Number of factories Capital	National Center for Industrial and Mining Information
Road Lengths	Ministry of Transport and Logistic Services

In addition to the data-driven phase, the study incorporated a qualitative component involving interviews with 12 industrial workers and 4 representatives from the supervisory body, namely the Ministry of Industry and Mineral Resources. These interviews aimed to discern the primary factors shaping the distribution of industrial workers in Saudi Arabia. From these discussions, 6 factors were identified, drawing upon prior research, including regional population size, urbanization, housing availability, factory density, capital investment, and average income. Interestingly, the variable of geographic area was not explicitly cited among the factors influencing industrial worker distribution; however, two interviewees suggested considering the number of factories in each region, prompting its inclusion subsequent to data acquisition.

To analyze the data, the present study drew insights from prior research in the field, as exemplified by studies [17, 19], which underscored the pivotal role of statistical methods in generating precise models depicting the relationships between variables and gauging the ability of independent variables to contribute to estimating and predicting the dependent variable's value. This assertion aligns with findings from studies [11, 20], which also affirmed the efficacy of various statistical methods and models. Among these, the Pearson coefficient emerged as prominent, facilitating the comprehension of relationships between variables in terms of directionality, magnitude, and strength. Additionally, multiple linear regression was highlighted for its capacity to assess the explanatory variables' ability to estimate the dependent variable's value and accurately predict future trends.

Consequently, these two statistical methods were selected to address the research questions and fulfill the study objectives. Several software systems were employed for this purpose, including ArcGIS Pro, Excel, and SPSS. For an in-depth understanding of the mathematical formulations underlying these methods:

A. Pearson Correlation Coefficient: The Pearson Correlation Coefficient is an important statistical method that is widely used with the aim of measuring the degree and direction of the correlation between a dependent variable (in this study it is: industrial workers) and a dependent variable, and it is calculated through the equation below:

$$R = \frac{\sum yixi - \frac{(\sum yi)(\sum yi)}{n}}{\sqrt{\sum yi_2 - \frac{\sum (yi)^2}{n}}\sqrt{\sum xi_2 - \frac{(\sum xi)^2}{n}}}$$

where, *xi*: independent variable, *yi*: dependent variable, *R*: correlation coefficient, *N*: number of observations.

The result of this equation varies between -1 and +1, where -1 means a perfect inverse correlation, +1 means a perfect direct correlation, while zero means no correlation [13, 27].

B. Multiple Linear Regression Analysis: Multiple linear regression analysis is a statistical method through which a statistical model is built with the aim of determining the relationship between quantitative variables: a dependent variable (in this study it is: industrial workers) and independent variables, and through it an equation appears. It shows the relationship between variables. It can be used to identify the type of relationship and the possibility of estimating the dependent variable through the use of independent variables. It is one of the most prominent methods used to predict the value of the dependent variable. The mathematical equation for it appears in this form:

$$yi=\beta 0+\beta 1xi,\ 1+\beta 2xi,\ 2+\epsilon i$$

where, *yi*: the dependent variable, *xi*: the independent variables, €: the random error, *βo*: a fixed value that expresses the value of *y* when the *x* values become zero, and *β* expresses the regression coefficients for the independent variables [23, 24].

Ultimately, the study encountered challenges in acquiring detailed data, particularly regarding the social and economic attributes of industrial workers due to its private nature. Consequently, non-specific data were utilized to attain a moderately comprehensive perspective.

4. RESULTS

4.1 Chronological growth of industrial workers

Through the data presented in Table 2, a trend of general growth in the number of industrial workers from 2009 to 2021 is evident. There is a consistent increase in numbers until 2017, followed by a slight decline in 2018, with approximately three thousand fewer industrial workers compared to the previous year. Subsequently, this decline persisted for two years until reaching 965,727 workers in 2020, after surpassing one million and fifty-three thousand workers in 2018. However, there was a resurgence in 2021, with an increase of approximately twenty-four thousand workers.

Upon historical observation of the growth in the number of industrial workers, it is noted that the overall pattern depicts an upward trajectory, barring the period from 2017 to 2020, characterized by a decline. This downward trend may be attributed to the significant drop in global oil prices, exceeding 70% of its previous value, which had ramifications on oil-producing economies. Despite this substantial decline, the negative impact on the number of industrial workers was approximately 7%, followed by a return to previous growth thereafter.

This trend aligns closely with findings [9, 15], underscoring the continued expansion of the industrial workforce. The temporary decline is attributed largely to factors associated with oil prices and the onset of the COVID-19 pandemic, with the overarching trend remaining one of sustained growth.

Table 2. Chronological growth of industrial workers

Year/Region	2014	2015	2016	2017	2018	2019	2020	2021
Riyadh	371592	376140	389254	400982	400235	361550	351026	351821
Qassim	28400	30387	31390	31854	32069	32770	33347	34496
Makkah	221212	234461	251737	254138	246004	225596	224691	223068
Madinah	34318	41543	44663	46843	47687	46535	45385	45650
Eastern	248109	255121	257336	255705	259126	248206	247306	250068
Jazan	6765	7310	8462	8504	9034	8930	9457	9001
Najran	3727	4164	4539	4639	4699	4266	4407	4290
Aseer	20769	22714	24969	25241	25616	26300	25493	25764
Albaha	640	758	1270	1320	1385	1457	1748	1542
Hail	10951	11197	11988	12686	12656	12664	9824	9750
Tabuk	5542	6496	6557	6574	6607	5678	5312	5078
Northern	2578	2823	4588	4523	4523	4364	4208	4126
Aljouf	2742	3279	3660	3710	3516	3372	3524	3467
Total	957345	996393	1040413	1056719	1053157	981688	965728	968121

In Table 2, concerning the administrative regions of Saudi Arabia, a consistent upward trend in the number of workers is observed over time, indicating the expanding growth within this pivotal sector and the annual influx of a greater workforce into it. However, a shift occurred in 2018, where a decline in the number of workers commenced, persisting for two consecutive years across most administrative regions, notably in the largest regions by industrial worker count such as Riyadh, Makkah Al-Mukarramah, and the Eastern Province. Notably, four regions bucked this trend of decline: Al-Qassim, Asir, Al-Baha, and Hail, collectively witnessing an increase of approximately 1,465 workers, constituting less than 2.5% of the total workforce during this period. This divergence from the broader declining trend may be attributed to the nature of industries prevalent in these regions, particularly in food and pharmaceutical sectors, and their relative resilience owing to a smaller number of industrial establishments.

4.2 Spatial analysis of industrial workers in Saudi Arabia

The spatial distribution of industrial workers exhibits considerable variation over time, as illustrated in Figure 1, highlighting the geographical dispersion of this workforce. Notably, the Riyadh region emerges as the primary administrative area hosting the highest concentration of industrial workers in Saudi Arabia, accounting for approximately 36% of the total industrial workforce, followed by the Eastern Region with 26%, and Makkah region with 23%. Remarkably, these three regions collectively encompass 85% of the total industrial workforce, underscoring their significant role in industrial employment. This distribution pattern aligns closely with the findings of Al-Sulai's study [9], which identified these three regions as focal points of industrial activity.

Subsequently, the Medina region ranks fourth with a share of 4.7%, followed by Qassim with 3.6%, and Asir with approximately 2.7% of the total industrial workforce in Saudi Arabia. Collectively, these three regions contribute 11% to the total industrial workforce, highlighting a notable concentration of industrial workers. Conversely, the remaining seven administrative regions collectively account for only 4% of the total industrial workforce.

The concentration of industrial workers appears to be predominantly centralized in regions spanning the central axis of Saudi Arabia from east to west, namely Riyadh, the Eastern Province, and Makkah. Conversely, this concentration gradually diminishes towards the northern and southern regions of Saudi Arabia. The underlying factors contributing to this spatial distribution will be further explored in this paper to elucidate the relationship between various economic and social factors and the geographical distribution of industrial workers across Saudi Arabia's regions.

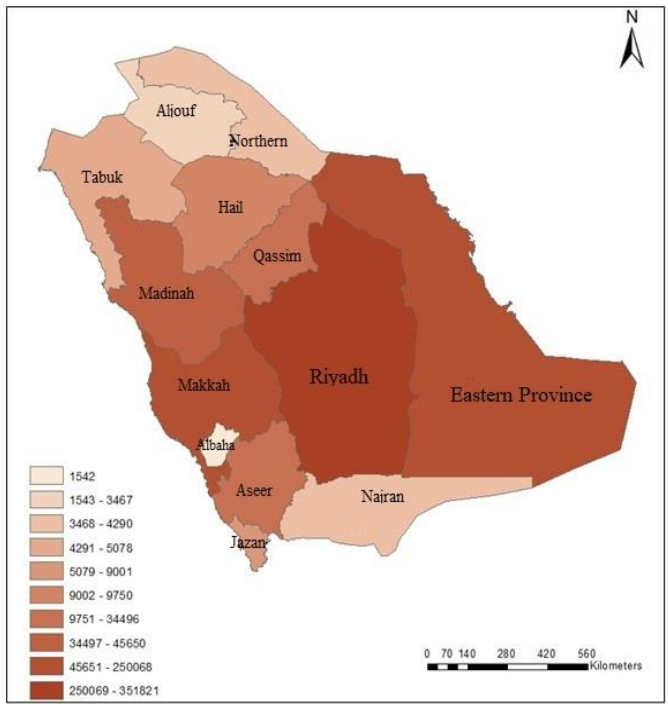

Figure 1. Spatial distribution of industrial workers in Saudi Arabia
Source: Author based on the base map from GEOSA [29]

4.3 Factors influencing the distribution of industrial workers in Saudi Arabia

Through a comprehensive review of literature and prior studies focusing on the spatial analysis of industrial elements, particularly industrial workers, as exemplified by researches [13, 14], coupled with insights gleaned from interviews with key stakeholders and officials regarding the determinants shaping the distribution of industrial workers in Saudi Arabia, a set of influential factors have been identified. These factors include population dynamics, geographic area, purchasing power, degree of urbanization, number of industrial establishments, average income levels, road lengths, and capital. Collectively, these factors represent essential elements contributing to industrial localization.

To ascertain the impact of these factors on the spatial distribution of industrial workers across various regions of Saudi Arabia, an analysis was conducted to examine the correlation between these factors and the distribution of industrial labor. The Pearson correlation coefficient was employed for this purpose, offering insights into the strength, direction, and degree of association between variables. Table 3 presents the results of this analysis, with the variable of industrial workers serving as the dependent variable, while the aforementioned factors are treated as independent variables expected to exert influence:

Population: The analysis of the Pearson correlation coefficient between industrial workers and population reveals a significant relationship at the 0.00 significance level, indicating a strong correlation between the two variables. This finding aligns with several prior studies [14, 16], although it contradicts the findings of Huang et al. [17], which suggested the absence of a positive relationship between these variables. Nonetheless, the consistent correlation underscores the pivotal role of population size and distribution in shaping the growth and distribution patterns of industrial workers. Essentially, regions with larger populations are better positioned to accommodate a higher number of industrial workers.

Area: Similarly, the correlation analysis indicates a direct relationship between industrial workers and area, with a significance level of 0.00. This finding underscores the correlation between these variables, suggesting that changes in the number and distribution of industrial workers can be discerned by examining changes in geographic area. The results underscore the significance of spatial dimensions in influencing the distribution and expansion of industrial labor. Specifically, regions with larger geographic areas tend to harbor a greater number of industrial workers, which is plausible given that expansive regions are more likely to accommodate industrial activities and, consequently, a larger industrial workforce.

Urbanization Rate: The Pearson correlation analysis indicates a direct relationship between urbanization rate and the number of industrial workers, with a significance level of 0.036, indicating a moderate degree of correlation. This suggests that changes in urbanization rates can to some extent predict the growth and distribution of industrial workers. The finding is consistent with the notion that urban areas typically host a larger industrial and service sector workforce compared to rural areas, where agricultural and pastoral occupations are more prevalent.

Number of Dwellings: Given its close association with population size, the number of dwellings in a geographic unit is expected to correlate with the number of industrial workers. Indeed, the Pearson correlation coefficient analysis reveals a significant relationship between these variables, reflecting the logical connection between residential units and the local workforce.

Number of Factories: As a fundamental component of industrial infrastructure, the number of factories is inherently linked to the industrial workforce. The Pearson correlation analysis demonstrates a strong relationship between the number of factories and industrial workers, with a significance level of 0.000. This underscores the critical role of industrial establishments in shaping the distribution of labor, alongside the correlation observed between capital and industrial labor.

Average Income: As a key indicator of purchasing power and market size, average income plays a significant role in shaping the distribution of industrial workers, where the results of Pearson's correlation analysis reveal a direct correlation between average income and the number of industrial workers. This indicates that average income levels can predict the distribution and growth of industrial workers to some extent, with an estimated correlation coefficient of approximately 58% and a significance level of 0.018, demonstrating statistical significance.

Road Lengths: Transportation infrastructure, as reflected in road lengths, is a crucial factor in industrial localization, facilitating access to raw materials, industrial facilities, and the workforce. The Pearson correlation analysis demonstrates a direct correlation between road lengths and the number of industrial workers, suggesting that road lengths can effectively predict the distribution and growth of industrial labor. The analysis indicates a strong correlation of approximately 87% between road lengths and industrial worker numbers, with a significance level of 0.000, highlighting the pivotal role of transportation in industrial workforce distribution and growth.

Table 3. Pearson correlation coefficient results

Dependent Variable	Independent Variable	Pearson	Sig.	Correlation
Industrial Workers	Population	0.938	0.000	Positive
	Area	0.801	0.000	Positive
	Urbanization	0.513	0.036	Positive
	Dwellings	0.906	0.000	Positive
	Number of Factories	0.993	0.000	Positive
	Capital	0.723	0.000	Positive
	Average Income	0.583	0.018	Positive
	Road Lengths	0.876	0.000	Positive

The analysis reveals varying degrees of positive correlation between the independent variables and the distribution of industrial workers. The results from Pearson's analysis (Table 3) indicate that the variable with the strongest correlation to industrial workers is the number of factories, with a Pearson coefficient of 0.993. A coefficient closer to 1 signifies a stronger correlation. Following closely are the variables of population and number of dwellings, ranked second in terms of correlation strength, succeeded by road lengths, geographical area, and capital. The variables of average income and urbanization rates exhibit a moderate correlation with industrial worker distribution. In conclusion, the outcomes of this section fulfill the second objective of this study, which is to ascertain the primary factors influencing the distribution of industrial workers in Saudi Arabia.

4.4 The role of industrial workers in the development of Saudi Arabia

In this section, the study aims to assess the impact of industrial workers on the development of the industrial sector in Saudi Arabia, as well as their contribution to the country's gross domestic product (GDP) in recent years (from 2009 to 2021). This assessment will be conducted through multiple linear regression analysis, with industrial workers as the dependent variable and industrial establishments, investment value in the industrial sector, and growth in the manufacturing sector's contribution to GDP as the independent variables. Multiple linear regression analysis facilitates the examination of relationships between variables, their direction, strength, and the extent to which the dependent variable can be

estimated and predicted by the independent variables.

The results of the multiple linear regression model are presented in Table 4, displaying the correlation coefficient values and their squares, alongside the significance and variance values. These results assess the feasibility of predicting the total score of the dependent variable based on the total scores of the independent variables. The analysis of variance in regression (F value) verifies the significance of the coefficient of determination (R^2), indicating the statistical significance of the prediction model. The statistically significant F value at a significance level of 0.000 underscores the significance of the prediction model.

The coefficient of determination (R^2) indicates that the independent variables contribute significantly, accounting for 96.6% of the variance in predicting the dependent variable. This substantial percentage underscores the strong association between the dependent variable and the independent variables, as also demonstrated by the analysis of the Pearson correlation coefficient. Consequently, the expansion of the industrial workforce notably fosters factory development, enhances investment in the industrial sector, and positively impacts Saudi Arabia's gross domestic product. Hence, the third objective of this study, focusing on delineating the role of industrial workers in industrial and economic development, is successfully attained.

Table 4. Multiple linear regression model for study variables

Independent	Dependent	Correlation Coefficient (R)	Coefficient of Determination (R^2)	F	F Sig. Level	Regression Coefficient	Beta	T	T Sig Level	Pearson	Sig.
GDP	Industrial workers	.983	.966	84.604	0.00	2.639	0.866	4.716	0.001	0.972	0.00
Investment							0.424	2.344	0.044	0.936	0.00
Factories							0.306	1.568	0.151	0.894	0.00

5. DISCUSSION

The present study offers a comprehensive examination of the historical evolution of industrial labor in Saudi Arabia, both at the level of administrative regions and across the nation as a whole. This investigation lays a robust groundwork for accomplishing the study's three primary objectives. Firstly, it entails a spatial analysis of industrial worker distribution within Saudi Arabia, aimed at elucidating regional patterns. Subsequently, it seeks to ascertain the extent to which the distribution of industrial workers correlates with key factors identified through a thorough literature review and stakeholder interviews. Ultimately, the study endeavors to gauge the developmental impact of industrial labor on the nation's economic and industrial landscape.

This investigation yielded several significant findings, with the most notable being the spatial distribution of industrial workers. It revealed that a striking 85% of these workers are concentrated in just three administrative regions—Riyadh, Makkah, and Eastern—out of the total thirteen. This observation underscores the substantial industrial clustering within these major regions, a trend consistent with the findings of prior studies [5, 10]. The concentration of industrial activity in these regions may be attributed to deliberate strategic objectives or historical factors, including the establishment of the first industrial cities in Saudi Arabia within these regions.

The primary objective behind this initiative was to foster the formation of industrial clusters aimed at promoting industrial integration and mitigating the financial burden associated with establishing requisite infrastructure and services for industrial operations. Furthermore, an observed trend indicates that as distance from the focal industrial hubs—namely, the three major regions—increases, there is a corresponding decline in the concentration of industrial workers. This phenomenon aligns with several developmental theories, including Hirschman's, which posits that such regions serve as developmental nuclei from which growth radiates outward. This assertion finds support in extant literatures [17, 25], which underscore the pivotal role of these regions in catalyzing broader developmental trajectories. Given these insights, stakeholders are encouraged to prioritize strategies aimed at dispersing industrial activities across diverse regions or targeting specific areas based on their inherent natural and human resources, thereby fostering comprehensive economic development.

The study's findings revealed several factors influencing the spatial distribution of workers through correlation analysis, indicating positive correlations among them to varying degrees. Notably, the relationship between the number of factories and population density emerged as the most closely associated factor with worker distribution. This outcome diverges from findings in some studies [17], which suggest that industrial employment tends to concentrate in cities with moderate population density, while service jobs cluster in densely populated urban areas. However, the disparity in results could be attributed to variations in city sizes and population figures between the study regions, namely Saudi Arabia and China.

In contrast, the study revealed a robust positive correlation between road lengths, income levels, urbanization rates, and the distribution of industrial workers. This finding underscores the significance of infrastructure, particularly the road network, in attracting industrial activities. Moreover, it highlights the influence of income levels on worker distribution, suggesting that workers tend to gravitate towards areas offering improved economic conditions. This outcome aligns well with previous research findings [9, 14, 26], thereby reinforcing the validity of the study's results.

Ultimately, the study elucidated a constructive role for industrial workers in fostering industrial development by facilitating capital attraction and enticing investors to establish manufacturing facilities. Industries, by their nature, benefit from skilled human resources capable of producing high-quality products and delivering added value. Furthermore, industrial workers play a constructive role in bolstering the gross domestic product through their contributions to the industrial sector.

Certainly, one of the primary limitations encountered by the present study pertains to the choice of geographical unit utilized for analysis. Employing administrative regions as the geographical framework may potentially yield less precise findings compared to a finer spatial resolution. A more

granular approach, such as using smaller spatial units, could offer enhanced accuracy, thereby bolstering recommendations conducive to industrial development. However, the feasibility of such an approach is impeded by data privacy concerns and the unavailability of pertinent data at smaller scales. This underscores the second limitation of the study: the lack of published data pertaining to industrial workers and other relevant variables at more localized levels, such as governorate or city levels. Access to such data could have significantly enriched the accuracy and significance of the study's findings.

6. CONCLUSIONS

In conclusion, this study provides a comprehensive exploration of the historical evolution of industrial labor in Saudi Arabia, spanning both administrative regions and the nation as a whole. Through a multi-faceted approach, the study successfully achieves its primary objectives of spatially analyzing industrial worker distribution, identifying influencing factors, and evaluating the developmental impact of industrial labor on the economy.

Key findings reveal a notable concentration of industrial workers in three major administrative regions—Riyadh, Makkah, and Eastern—comprising 85% of the total workforce. This concentration underscores the significance of industrial clustering within these regions, potentially attributed to strategic objectives or historical precedents such as the establishment of initial industrial cities.

Furthermore, the study highlights the importance of industrial clusters in promoting integration and alleviating infrastructure costs. It also observes a diminishing concentration of workers with increasing distance from focal industrial hubs, consistent with developmental theories like Hirschman's. This underscores the pivotal role of major regions in catalyzing broader developmental trajectories, as corroborated by existing literature. The study identifies various factors influencing worker distribution, including the number of factories, population density, road infrastructure, income levels, and urbanization rates. Notably, a positive correlation is observed between these factors and worker distribution, underscoring the significance of infrastructure and economic conditions in attracting industrial activities.

Ultimately, the study elucidates the constructive role of industrial workers in fostering industrial development, facilitating capital attraction, and contributing to GDP growth. However, limitations stemming from the use of administrative regions as geographical units and data unavailability at finer spatial resolutions are acknowledged. Addressing these limitations could enhance the precision and significance of future research endeavors, ultimately contributing to more targeted and effective strategies for industrial development in Saudi Arabia.

ACKNOWLEDGMENT

This work was supported and funded by the Deanship of Scientific Research at Imam Mohammad Ibn Saud Islamic University (IMSIU) (Grant No.: IMSIU-RG23135).

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