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Achieving sustainable development goals through water and sanitation in sub-saharan africa: The role of industrialization

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ABSTRACT

Previous research has focused on the effect of infrastructure development on industrialization. However, the industrialization process can also be a source of social transformation. Thus, the objective of this study is to analyze the impact of industrialization on some indicators of sustainable development in particular the infrastructure development index, access to water and access to sanitation in sub-Saharan Africa (SSA). The data was collected from 27 countries in sub-Saharan Africa from 2000-2016. The Ordinary Least Square (OLS) and Generalized Least Square (GLS) methods were used to estimate the parameters of our econometric models. The results of the study show that industrialization has a positive and significant impact on all infrastructure indicators. Furthermore, tariff rates and political stability are also explanatory factors for the sustainable development indicators. Therefore, SSA countries which are mostly endowed with natural resources must increase their industrialization process in order to improve the social structures of their populations through the development of infrastructure. More precisely, the exploitation and transformation of their raw materials may help fight against underdevelopment through inclusive growth and the development of infrastructure.

Contribution/Originality: This study highlights the effect of industrialization on sustainable development indicators such as infrastructure in the SSA countries. It demonstrates that an improvement in social transformations can also pass through the intensification of the industrialization process.

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1. BACKGROUND

The Millennium Development Goals (MDGs) were developed by the United Nations in the 2000s in order to address global inequality and poverty. No African nation has managed to reach the sanitation objective at the end of the programme. Additionally, several African nations have been successful in decreasing the percentage of people who lack access to clean water (WHO/UNICEF Joint Water Supply & Sanitation Monitoring Programme, 2015). The percentage of the population using drinking water services and sanitation facilities improved from 61% to 71% and from 28% to 43% respectively from 2000 and 2015 (United Nations, 2019), although the African situation has not improved. A new agenda was established in 2015 because the Millennium Development Goals have not been achieved. Goal six of this agenda aims to ensure access to water and sanitation.

According to Headey and Palloni (2019), the health of children depends mainly on investments in access to water and sanitation. However, 29% of people lacked access to clean drinking water until 2017 and 55% of the world's population lacked better sanitation facilities. The situation in sub-Saharan Africa was especially concerning because 39% of the population lacked access to better sanitation, compared to 69% of the population who lacked access to

drinking water (WHO & UNICEF, 2019). The differences between urban and rural areas have long existed on the African continent with 84% of urban residents having access to drinking water and 44% having better sanitation. On the other hand, 45% of the rural population has access to drinking water compared to 22% who have improved sanitation services (WHO & UNICEF, 2019).

The African continent has been able to better understand its infrastructure needs by taking these shortcomings into consideration. Consequently, the Infrastructure Development Index for Africa had a steady rise in scores, rising from 17.13 units in 2009 to 28.44 units in 2017 (AfDB, 2018; World Bank, 2018). According to the Africa Infrastructure Development Index (AIDI), fragile nations are still struggling while low-income states are making quick progress.

Although progress has been made mainly in information and communication technologies (ICT) and access to water and sanitation, electricity production has stagnated and transport development has not improved (Laborda & Sotelsek, 2019; Tumbare, 2015). At this level, the infrastructural success of Kenya, Ghana and Senegal is highlighted because of the greatest outcomes attained in the ICT sector. There are also countries that are still lagging behind in terms of infrastructure development (Madagascar, Niger and Chad) but are making progress (IMF, 2014).

The budgetary constraints of African countries do not allow them to finance most of their infrastructure which is why they resort to external debt to support their investment projects (Kapindula & Kaliba, 2022). In the African context, most of these investment projects relate primarily to infrastructure development across the continent. In fact, in 2009, the World Bank published a report on infrastructure in Africa in which it was estimated that approximately US$125 billion would be needed per year to meet the infrastructure needs of sub-Saharan Africa alone (Briceno-Garmendia, Cecilia, & Foster, 2009). But in 2014, total infrastructure funding on the continent was estimated at just US$74.5 billion (Bond, 2016).

There is an interdependence between industrial development and infrastructure because the development of infrastructure promotes the process of industrialization. On the one hand, the industrial development of any region impacts the infrastructure. Therefore, infrastructure development is necessary for the development of a country or region and vice versa.

Industrial development improves people's quality of life through social transformation. The pioneering works on the relationship between industrialization and social transformation are those of Parsons (1951) and Maizels (1963).

Several studies have analyzed the impact of industrialization on social transformation including poverty (Haraguchi & Kitaoka, 2015), education (Kerr, 1962), culture (Prasad, 1957), housing, public health and infrastructure (Sharma, Vashist, & Sharma, 2008).

The development of infrastructure through new productive activities in a region also contributes to improve the living conditions of residents of the community. In other words, residents should enjoy socio-economic benefits from the existence of industry in the regions.

Access to water and sanitation have been ignored by studies on the relationship between industrialization and infrastructure. According to the World Water Development Report (2019), more than half a billion people in sub-Saharan Africa do not have access to improved sanitation facilities (United Nations, 2019). In addition, around 500 children die every day in the world due to a lack of water, sanitation and hygiene services[1].

The general introduction constitutes the first section of this work. Section two presents the literature review. The methodological approach is developed in section three. The presentation of the results is presented in section four and section five concludes.

2. LITERATURE REVIEW

This section is based on twoparts: the theoretical foundations and the empirical evidence.

2.1. Industrialization and the Transformation of Social Structures: A Theoretical Approach

The influential studies that showed how industrialisation affects a community's family structure include those by Parsons (1951), Thompson (1996), Moore (2001) and Linton (2001). Parsons (1951) demonstrated that industrialisation has an impact on changes in family structures in the areas where the industry is located. On the other hand, Linton (2001) was interested in change at the individual level. According to him, industrialization changed family dynamics and liberated men and women from economic dominance. Thus, the location of industries in a community leads to changes at the individual level and at the community level. However, Thompson (1996) demonstrated that the industry brings more problems to the community than the community has ever had before.

In a broader context, authors such as Maizels (1963) showed that industrialisation can occasionally lead to an increase in prosperity, job possibilities, the growth of commerce and technical advancement. Moreover, Moore (2001) highlighted the fact that the development of the industry creates business opportunities in the community. According to Miller (1984), community infrastructure plays a role in the socioeconomic effects of industry-driven community growth but this is not the only factor supporting social and economic development.

2.2. Empirical Evidence of the Relationship Between Industrialization and Social Transformations

The reduction of income inequality and poverty is strongly associated with the development of the manufacturing sector (Haraguchi & Kitaoka, 2015). As a result, the choice of a country's industrialization model is an explanatory factor for its social indicators. Haraguchi and Kitaoka (2015) forged the need for "smart

[1] https://www.un.org/africarenewal/fr/derni%C3%A8re-heure/afrique-subsaharienne-500-enfants-meurent-chaque-jour-%C3%A0-cause-du-manque-deau-salubre

industrialization" linked to the structural understanding of the evolution of manufacturing production capacities which will have an impact on the creation of decent jobs, food security and equitable growth, conditions necessary for the sustainable eradication of poverty depending on the income level of each country.

In addition to poverty reduction, there are other indicators of social transformation such as infrastructure, education, housing, roads and public health.

The work of Kerr (1962) led to the conclusion that industrialization makes the labor market more dynamic and as income increases, the level of education also increases.Similarly, Prasad (1957) demonstrated that industrialization has a positive impact on the economic life as well as the social and cultural life of a community (access to education, high quality housing, health infrastructure and many other infrastructures).

The literature review has highlighted the various issues related to industrialization and development (Dadibhavi, 1991; Dhar & Lydall, 1961; Gayithri, 1997; Lal, 1987; Reddy, 1990). Sharma et al. (2008) analyzed the impact of industrialization on infrastructure development in India (Himachal Pradesh). Social and economic infrastructure in the form of housing, education, public health, commerce and other modern conveniences of life in Himachal Pradesh have been improved by industrial development.

On the other hand, the work of Sharma et al. (2008) remains the only study on the effect of industrialization on infrastructure development.

3. METHODOLOGY

The following infrastructure development model has been developed from the works of Ndikumana and Pickbourn (2017) and Sosson, Njagang, Ningaye, and Nourou (2020):

$$IDI_{it} = \beta_0 + \beta_1 Manufact + \beta_2 X_{it} + \delta_i + \gamma_t + \mu_{it} \quad (1)$$

Where IDI_{it} represents the infrastructure development index of country i during the period t, $Manufact$ rrepresents industrialization for country i during the period t, X_{it} is a vector that includes all the controlvariables , δ_i is an unobserved specific effect of a given country, γ_t is the time specific effect and μ_{it} is the error term. To carry out our study, we used a panel of 27 countries from 2000-2016.

The relationship between the explanatory variables and the dependent variable is established in this work by referring to the existing literature on infrastructure development. Sharma et al. (2008) showed that industrialization has a positive and significant effect on infrastructure development. Kengdo, Nchofoung, and Ntang (2020) find that inflation has no effect on infrastructure development. Yet governance and trade openness individually have a negative and significant effect on infrastructure development (Kengdo et al., 2020). On the other hand, Sosson et al. (2020) found that trade openness has no effect on infrastructure development.

We used the Generalised Least Squares approach which is resistant to autocorrelation and heteroscedasticity to evaluate the link between industrialization and infrastructure development in a static panel. But before, the OLS technique was used to obtain the baseline results.

4. RESULTS

This section is organized into three points. The first presents descriptive statistics. The second describes the results obtained by the Ordinary Least Square method while the last describes the results obtained by the Generalized Ordinary Least Square method.

4.1. Descriptive Statistics

Table 1 presents a summary of some statistical indicators. As for Table 2, it presents the correlation matrix. Table 2 shows a positive correlation between industrialization and infrastructure (access to water and sanitation). These correlations are confirmed by the three graphs below. Figures 1, 2 and 3 illustrate the relationship between industrialization and the various infrastructure indicators.

Table 1. Descriptive statistics.

Variables	Obs.	Moyenne	Ecart-type	Min.	Max.
IDI	459	13.31	10.81	0.96	78.97
Eau	459	56.88	14.99	19.89	92.27
U-Eau	459	81.19	9.73	58.42	98.87
R-Eau	459	41.96	14.65	4.08	79.82
Ass	459	27.24	15.49	4.32	76.01
U- Ass	459	18.83	13.38	1.19	72.60
R-Ass	459	40.49	16.20	9.43	88.44
Manuf	459	10.20	5.09	0.23	24.55
Inv	459	64.24	245	-3.81	2108.46
Inf	459	15.31	123	-9.61	2630.12
Tarif	459	9.96	4.52	0.5	29.87
Polits	459	-0.69	0.87	-2.69	1.105

Table 2. Correlation matrix.

Variables	IDI	Eau	Ass	Manuf	Inv	Inf	Tarif	Polist
IDI	1.00							
Eau	0.74	1.00						
Ass	0.81	0.74	1.00					
Manuf	0.18	0.20	0.21	1.00				
Inv	-0.041	-0.044	0.017	-0.18	1.00			
Inf	-0.06	-0.09	-0.02	-0.02	0.008	1.00		
Tarif	-0.033	-0.18	-0.27	0.15	-0.01	0.02	1.00	
Polist	0.31	0.30	0.27	-0.06	0.30	-0.09	-0.35	1.00

Note: IDI: African Infrastructure Index; Eau: Drinking water; Ass: improved sanitation; Manuf: Industrialisation; Inv: Domestic investment Inf: Inflation; Tarif: Tarif rate; Polist: Political stability.

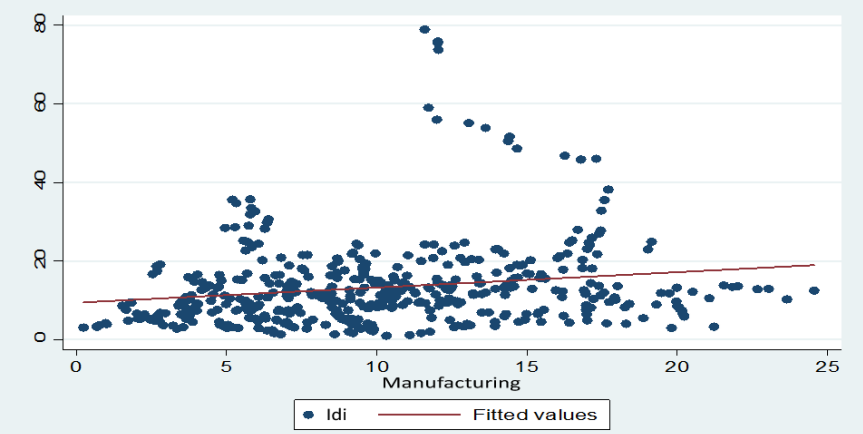

Figure 1. Industrialization and infrastructure development index.

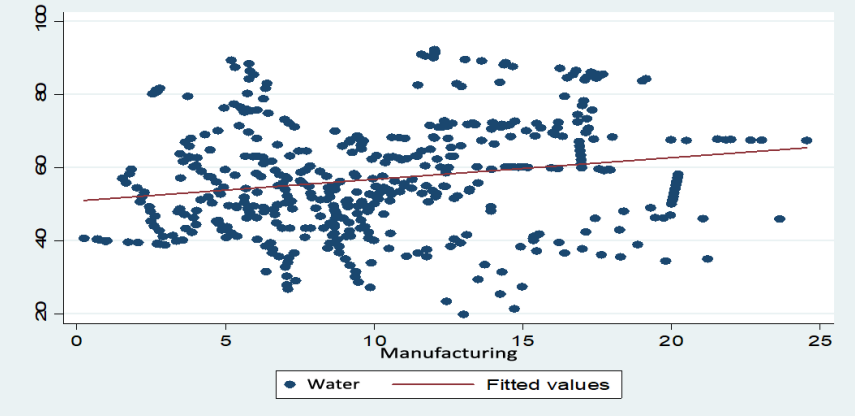

Figure 2. Industrialization and access to drinking water in the total population.

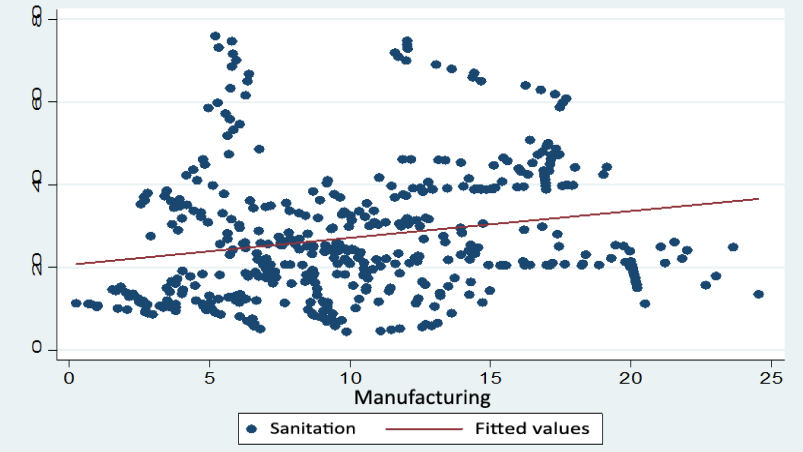

Figure 3. Industrialization and access to sanitation in the total population.

The results are presented in the various tables below. We used the Ordinary Least Squares method to obtain the basic results. Subsequently, we used the Generalized Least Squares method which is robust to autocorrelation and heteroskedasticity of errors.

4.2. Basic Results through the OLS Method

The use of the Ordinary Least Squares method gives results which are given in Table 3. The results of this table reveal a positive and significant association between industrialization and the various infrastructure indicators. Thus, an increase in the manufacturing sector of 1% will lead to an improvement of 0.55%, 0.75% and 0.89% respectively for the index of infrastructure development, access to drinking water and sanitation. Industrial development requires enormous investment in infrastructure which is useful for businesses on the one hand and for the surrounding populations on the other. This result is compatible with the work of Sharma et al. (2008) according to which the construction of industries in a region of India (Himachal Pradesh) led to the development of the various infrastructures of the region.

When comparing the improvement of water and sanitation infrastructure in urban and rural areas, a 1% increase in manufacturing will result in a greater improvement of these infrastructures in rural areas than in urban areas (0.91% for access to water in rural areas compared to 0.32% for this same infrastructure in urban areas and 0.87% for the improvement of sanitation in rural areas compared to 0.76% for this same infrastructure in urban areas). The majority of processing-specific industries are found in rural areas rather than urban ones which helps to explain this outcome.

Political stability has a positive and significant effect on infrastructure development. Thus, an improvement in political stability of 1% will lead to an increase of 3.14%, 5.11% and 4.52% respectively for the infrastructure development index, access to drinking water and sanitation. This result is justified by the fact that a stable environment is conducive to infrastructure development. This result is contrary to the work of Kengdo et al. (2020).

Table 3. Effect of industrialization on infrastructure (OLS).

Variables	IDI	Water	Urban water urban	Rural water	Sanitation	Urban sanitation	Rural sanitation
Manuf	0.550*** (0.00)	0.751*** (0.00)	0.321*** (0.00)	0.913*** (0.00)	0.890*** (0.00)	0.768*** (0.00)	0.873*** (0.00)
Inv	0.003* (0.07)	0.005** (0.04)	-0.004*** (0.00)	0.009*** (0.00)	0.009*** (0.00)	0.015*** (0.00)	0.005** (0.02)
Inf	-0.002 (0.502)	-0.007 (0.17)	-0.005* (0.09)	-0.009* (0.06)	0.001 (0.79)	-0.002 (0.64)	0.002 (0.6)
Tarif	-0.679*** (0.00)	-0.400** (0.01)	-0.356*** (0.00)	-0.862*** (0.00)	-0.791*** (0.00)	-0.742*** (0.00)	-0.700*** (0.00)
Polits	3.147*** (0.00)	5.116*** (0.00)	2.940*** (0.00)	2.997*** (0.00)	4.529*** (0.00)	5.074*** (0.00)	3.011*** (0.00)
Cons	16.472*** (0.00)	56.504*** (0.00)	83.897*** (0.00)	42.899*** (0.00)	28.56*** (0.00)	42.610*** (0.00)	18.57*** (0.00)
R^2	0.22	0.16	0.19	0.20	0.19	0.18	0.19
Prob(F)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
N.obs	459	459	459	459	459	459	459

Note: ***, **, *: represent significance levels at 1%, 5% and 10% respectively. Values in parentheses represent probabilities.

Customs tariffs have a negative and significant effect on the various infrastructure proxies. Thus, an increase in tariff barriers of 1% leads to a slowdown of 0.67%, 0.4% and 0.79% respectively for the infrastructure development index, access to drinking water and sanitation. This result can be explained by the fact that the rise in customs tariffs slows down imports of inputs useful in production or the improvement of infrastructure at the local level. This result is contrary to the work of Sosson et al. (2020) who found no effect.

The VIF (Variance Inflation Factor) test for each model was performed to ensure that this estimate is unbiased. This test aims to identify a possible case of multicollinearity. The result of this test is recorded in the tables below. Overall, the VIF test does not present any cases of multicollinearity because the values of each variable are less than 10 for each model. The result of this test is recorded in Table 4, 5 and 6.

Table 4. Results of the variance inflation factor test for the infrastructure development index equation.

Variables	VIF	1/VIF
Polist	1.31	0.76
Tarrif	1.18	0.84
Inv	1.17	0.85
Manuf	1.07	0.93
Inf	1.01	0.98
Moyenne	1.15	

Table 5. Results of the variance inflation factor test for the water equation.

Variables	VIF	1/VIF
Polist	1.31	0.76
Tarrif	1.18	0.84
Inv	1.17	0.85
Manuf	1.07	0.93
Inf	1.01	0.98
Moyenne	1.15	

Table 6. Results of the variance inflation factor test for the sanitation equation.

Variables	VIF	1/VIF
Polist	1.31	0.76
Tarrif	1.18	0.84
Inv	1.17	0.85
Manuf	1.07	0.93
Inf	1.01	0.98
Mean	1.15	

4.3. Effect of Industrialization on Infrastructure through the GLS Method

The results of the estimation of infrastructure models using the Generalised Least Squares approach are shown in Table 6 and are strong due to autocorrelation and heteroskedasticity of errors. All the results recorded in this table are identical to those found by the OLS method. For example, the manufacturing sector has a positive and significant impact on all infrastructure development proxies (infrastructure development index, access to drinking water and access to sanitation). Table 7 presents the results obtained through the GLS method.

Table 7. Effect of industrialization on infrastructure (GLS).

Variables	IDI	Water	Urban water	Rural water	Sanitation	Urban sanitation	Rural sanitation
Manuf	0.550***	0.751***	0.321***	0.913***	0.890***	0.768***	0.873***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Inv	0.003*	0.005**	-0.004***	0.009***	0.009***	0.015***	0.005**
	(0.07)	(0.04)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)
Inf	-0.002	-0.007	-0.005*	-0.009*	0.001	-0.002	0.002
	(0.4)	(0.16)	(0.09)	(0.059)	(0.78)	(0.64)	(0.6)
Tarrif	-0.679***	-0.400***	-0.356***	-0.862***	-0.791***	-0.742***	-0.700***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Polits	3.147***	5.116***	2.940***	2.997***	4.529***	5.074***	3.011***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Cons	16.472***	56.504***	83.897***	42.899***	28.568***	42.61***	18.572***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Prob(Chi2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nb.Obs	459	459	459	459	459	459	459

Note: ***, **, *: represent significance levels at 1%, 5% and 10% respectively. Values in parentheses represent probabilities.

5. CONCLUSION

The relationship between infrastructure growth and industrialization has received significant attention in the economic literature. Nevertheless, industrial development could also lead to an improvement in the living conditions of populations through access to infrastructure. To analyze the effect of industrial development on infrastructure such as access to drinking water and sanitation data was collected from 27 countries in sub-Saharan Africa from 2000-2016.

The methods of Ordinary Least Squares and Generalized Least Squares were used to estimate the parameters of our econometric model to achieve our results. Our estimates show that industrialization has a positive and significant impact on all infrastructure indicators (including the infrastructure development index, access to drinking water and sanitation).

The use of the GLS method gives results that are compatible with those of the OLS. SSA countries must establish and implement realistic industrialization plans that no longer rely on external aid (because official development assistance has never industrialized a country) but rather on the exploitation and transformation of their raw materials in order to fight against underdevelopment through inclusive growth and the development of infrastructure.

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Transparency: The author states that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.
Competing Interests: The author declares that there are no conflicts of interests regarding the publication of this paper.

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