Supporting industrial investments in underdeveloped countries through a competency model for manufacturing workforce

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Abstract: During the last years, business leaders and big investors have recognized huge potential in different underdeveloped countries. Investments in the industrial sector – and specifically in labour-intensive manufacturing production sites – represent today a potential strategic resource for the growth of underdeveloped countries. However, investments from the private sector in industrial development remain low. Beyond conflicts and political instability, a main reason why companies hesitate to set up businesses in underdevelopment countries is the lack of an industrial strategy for penetrating these areas. Indeed, this shall move from focusing on natural resources and infrastructure to manufacturing opportunities. Here, however, the profound cultural and attitudinal differences of workforce and general employees complicate the development and sustainability of industrial investments. Consequently, this research aims to create a detailed model that thoroughly describes the human competence specifically needed for manufacturing industries, in order to productively support investments in underdeveloped territories. In this paper an individual competency model is presented in order to capture the main dimensions that define blue-collars' skills in different manufacturing sectors, starting from the analysis of the categories of industrial skills. The proposal has been validated in two specific industries, taking as a reference the African continent, which currently seems to ensure the bigger opportunities for investments in manufacturing sites. The proposed approach can be useful for guiding investment plans for manufacturing companies in undeveloped countries, supporting the identification of the skills required by specific industrial sites.

Keywords: Manufacturing Competence; Underdeveloped Countries; Industrial Development

1. Introduction

It is well recognized that industrialization is able not only to create fast structural change but also to guide socio-economic development, representing the basic point for alleviate poverty and unemployment (Signé & Johson 2018). A recent report (UNIDO, 2016) also highlight that moving from an agrarian economy to an industrial one is essential for creating wealth in a country. In particular, supporting the development of manufacturing in underdeveloped countries will help to achieve the Agenda 2030 goals (United Nations, 2016). However, despite the clear benefits of industrialization, there are several problems that occurs when industrial business is established in underdeveloped countries. Underdeveloped countries are characterized by low income per capita and poor conditions, low education and lack of an effective health care system. Furthermore, underdeveloped countries have obsolete methods of production and unappropriated social organization, often combine with high population growth. In order to identify underdeveloped countries and categorized them, the so-called Human Development Index (HDI) (World Population Review, 2020) is used. This index takes in consideration human development such as education, life expectation and per capita income. The calculation based on this index reveal that the ten most underdeveloped countries in the world are African nations. For this reason, the present work focuses on the African continent. Business leaders and big investors have nowadays recognized the great potential of African territories: African population will reach 2 billion people by 2050. This means that Africa would become the largest pool of labour in the word. However, the rate on unemployment in those nations remains high (e.g. youth unemployment in Nigeria is at 42.2 %) – more than 10 million young people enter the workforce every year and only 3 million of job are created (Yuan Sun, 2017). In addition to the large workforce, Africa has the availability of low-cost labour and an abundance of natural resources. Therefore, a structured approach is essential to sustain this growth, in order to create productive employment for the population and economic benefits for the companies. Specifically for African countries, the importance of industrialization is also confirmed by the Agenda 2063 (African Union Commission, 2015) and the African Development Bank-Group (2016), according to which it is one of the five priorities that most rapidly lead to create added value for both companies and population. In spite of those opportunities, indicators of industrial development grow slowly and, due to the presence of natural resources, there

is not enough focus on manufacturing industry (Signé & Johson, 2018). Also, direct investment remains low and, as shown in the following image, three-quarters of total greenfield investment are located on industries based on natural resources (UNCTAD, 2018).

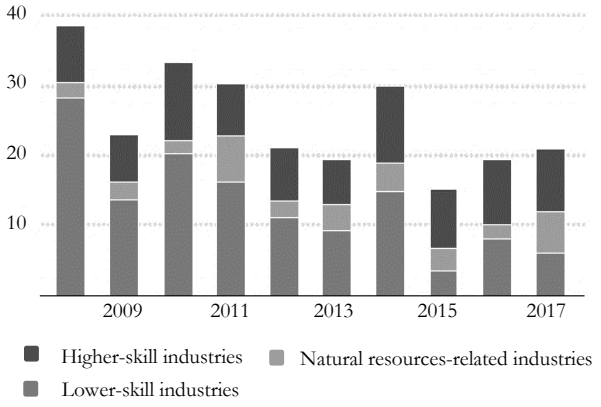

Figure 1: Value of FDI greenfield projects in manufacturing, 2008-2017 in Africa (UNCTAD, *World Investment report*, 2018)

A very recent research (Deloitte, 2016) indicates that there are four main drivers that impact industry's development and investment in the manufacturing sector, which are: human capital, cost, suppliers network and domestic demand. The first factor is human capital, defined as the "stock of economically productive human capabilities", particularly important for labour intensive sectors (AIDA, 2017). It is well known that the capacity of a firm to be flexible, productive and innovative is linked to the high level the quality of human capital. Specifically, the level of "human capital" means how much the country can respond to any shifts in the production, by looking at both current labor force capabilities as well as the long-term ability to cultivate the right skills and talent in the future workforce.(World economic forum, 2018).In Africans nations the quality of human factor is also related to social factors, as conflict, sanitarian problem and cultural aptitude that represents an obstacle for industrial development. Human capital is fundamental to improve total factor productivity and to help countries adopting new technologies. In this field, the African Union Commission stated the importance to create a framework that supports the development of competences, skills and knowledge inside a specific industry (African Union Commission, 2017). The aim of this framework is to understand, for every type of industry, which are the main individual competency for the blue-collar categories. This tool can both guide investors in understanding which industry is suitable for the specific territory and support the development of the capabilities for the specific job. The relevance on this topic is testified by the African Union Plan of Action for the Acceleration of Industrial Development in Africa (PIDA), which explicitly mentions capabilities development as a priority in the and in the Agenda 2063. Here, the authors propose a model that, given a set of jobs, standardizes the way of defining the associated tasks, knowledge, skills and attitudes. The paper is therefore divided into two main parts: in the first part, a literature review of the scientific contributions related to developing skills inside the industry is presented; the second part of the paper describes the model for standardizing the tasks, skill and attitude and knowledge categories and shows the application on two different type of industry.

2. Literature Review

Several studies in the broader literature examine African manufacturing trends and clearly show that key values of the manufacturing field are still lower than expectation. Africa Union (2018), the international organisation including all African states - during the annual economic report of the African Union Commission and in collaboration with the OECD Development Centre - is taking forward the project for African integration and transformation by promoting initiatives to drive development strategies. These include the simplification of private investment for the benefit of business productivity, technology and know-how, such as the modernisation of urban infrastructure and services and inclusive social development, through education aligned with labour market needs. In this sense, it is important to investigate which are the different strategies that support these initiatives. In the book "Improving manufacturing performance in South Africa: The report of the Industrial Strategy Project", Joffe and Kaplan focus on how to build an industrial policy, looking at four main objectives: first creating employment, secondly increasing investment, than raising productivity and improving performance (Joffe & Kaplan, 1995). In order to achieve these objectives four main strategies are proposed: industrial specialisation; beneficiation of natural resources; targeting of key capabilities and empowerment productivity growth. The need of building capabilities in order to support industry's development is an important point for this research. Indeed, as James in "Capacity Building in Developing Countries: Human and Environmental Dimensions" shows, only financial aid does not automatically guarantee better education, general improvement in infrastructure, or proper skills enhancement, but it is necessary to develop appropriate programs to support key capabilities development inside the industries (James, 1998). In addition, governmental institutions have to integrate new approach to education, training and employment in order to promote new approaches for skills development (OECD, 2008). As a matter of fact, for MNEs (Multinational Enterprises) operating in Africa one of the main problems is the lack of skills and the need to develop, recruit and maintain it inside the company. Generally, skills are obtained through specialized education or training. However, educational reforms often require complex process and is it useful to support this process from the research side. Filling the skill gap requires a framework that helps at matching demand and supply of competences for manufacturing fields (Osabutery & Nyuur, 2010). Often this role is left to institution that designs and generates key capabilities for industries, but the challenge of building tools for supporting MNE in Africa on the competency side has not having the adequate attention by researchers and practitioners. An example of institution is African

Capacity Building Foundation, established in 1991 with the aim of developing individual, organizational, and institutional capabilities. Moreover, another great push in the skill development policy came from European Union funding tranche, that provides several policy and strategies in order to support skills development (Peliwe, et al., 2015). However, although these institutions try to support and invest in capacity development initiatives, they do not present any specific framework to support investors in the identification and development of industrial capabilities. The literature review highlights a lack of appropriate guidelines that support companies in developing the adequate individual competencies to support industrial process in African countries. This paper aims to address a contribution on the competency side in underdeveloped countries, so far lacking in the scientific literature. Indeed, referring to the triple helix model of innovation (Etzkowitz, 1995), that shows the importance of the interaction between universities, industries and governments in order to foster economic and social development, this paper both help the investors and the institutions working on industry capabilities.

3. Individual competency model

To date there seem not to be frameworks supporting MNEs decisions on choosing to expand their business or invest in underdeveloped countries. In these cases, a competency model may support not only the choice of which type of industry can be developed in a specific country, but also guide investors in understanding which type of skills are necessary. Aiming to contribute on this field, in this section an individual competency model for the blue-collar categories, is proposed. In order to formalise the individual's competency needed for a specific job, it is necessary to define standard categories of tasks, skill & attitude and knowledge. The jobs taken in consideration are only referred to blue collars; for this reason, the categories of tasks taken in consideration are all "operating" and not "strategic". In order to build the model, the database of the Italian ISFOL institute (*"Istituto per lo sviluppo della formazione professionale dei lavoratori"*) has been analysed. Specifically, ISFOL is a national agency that works in the field of training and social policies, in order to contribute to the employment growth, improve human resources and promote social inclusion and local development. Moreover, the Institute provides a wide database, in which all the existing professions are categorized in 800 professional units and described considering more than 300 variables. After a deep analysis of ISFOL data, a new model for individual competencies is proposed. Specifically, in order to build the standards tables, the methodology followed in this paper is divided in three main parts:

1. First, after a deep analysis of the competency structure proposed by ISFOL, a hierarchical model of individual competencies for the blue-collar class has been structured. Specifically, one job is described by all the tasks needed to perform it, and by skill and attitude and knowledge that are necessary to approach the job;
2. Secondly, for this study, 952 descriptions have been analysed from ISFOL database. The dataset was divided into 153 task, 704 skill and attitude and 95 knowledge descriptions. From task analysis 16 "action classes" have been defined. Each class of action correspond to a specific group of verbs that describe the same activity. Specifically, the classification consists in grouping different activities that require similar competency to be performed. To define the above mentioned classes the following methodology has been used:
   a. For each task the description has been analysed through the identification of the specific verb that charactherized the task;
   b. Then among all the previously identified verbs, the more recurrent ones have been taken as the main classes (e.g "control", "execute" etc.);
   c. Verbs that describe similar activities have been grouped to the main one (e.g. "repair" and "adjust" in "maintain");
   d. The final classification consists in the classes resulting from point c. coupled with the specific object of the action (e.g. "control" with "conformity");

   The same procedure has been implemented for the skill and attitude and knowledge categories, taking into account the keywords of the specific description;
3. After that, a standard model for describing jobs, through the proposed standard categories of tasks, knowledge, skills and attitudes has been built, in order to have a standard description of every single job.

In the following sections the model is more detailed. It is worth to notice that the categories are general in order to group inside the same section similar dimensions and use them to classify, analyse, and describe different jobs.

3.1 Model structure

The model, as shown in Figure 2, has a hierarchical structure. In order to define the competency of the blue-collar it is necessary to define job's categories to be included on the description of each industry. Moreover, every job is further described by three elements:

1. Definition of the sequence of tasks related to the specific job;
2. Definition of the set of skill and attitude needed for the specific job;
3. Definition of the knowledge needed for the specific job.

3.2 Tasks

The task category includes all the information about the specific activity that the operator has to execute. On the ISFOL's dataset, tasks are described by long sentences and this approach does not help the visualization on the task category. Moreover, this method of description does not allow to understand which task category is more important to focus on for every industry. For these reasons, in this section a standard model for describing activity is proposed. Specifically, the definition of a single task is classified by a macro-category with the related details, as shown in Table 1. For each task, three main dimensions have been defined:

1. Complexity, that measures the complexity of the task and specify if the task requires a high or low skill level (e.g. use of technology);
2. Frequence, that measures how frequently the task is repeated;
3. Criticality, that measures how critical the task is for achieving the result.

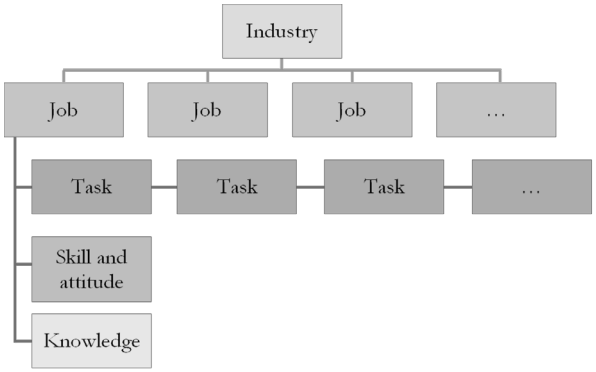

Figure 2: Individual competency model hierarchical structure

Table 1: Standard task categories

Macro category	Detail
Analyse	Data
	Machine
	Material
Apply	Procedure
Choose	Material
	Method
	Product
	Solutions
Collect	Data
	Product
Control	Conditions
	Conformity
	Equipment
	Machine
	Process
	Product's quality
	Status
Define	Standard
Design	Layout
	Machine
	Product
Execute	Add material
	Assemble parts
	Clean machine
	Label
	Load or Unload materials
	Measure products or materials
	Pack
	Prepare materials
	Set-up
	Substitute part or materials
	Use the machine
	Weigh products or materials
Manage	Supplier
	Costumer
Maintain	Equipment
	Machine
	System
Modify and Program	Machine
Purchase	Material
Stock	Product
Supervise and coordinate	Department
	Process
	Team
Test	Material
Verify	Procedure

Specifically, the dimension of "importance", here presented as "criticality", and the dimension of "frequence" are taken from ISFOL database. In addition to these ones, a new dimension of "complexity" is also presented, in order to extend the description of the tasks. In particular, frequence and criticality are representative of the relevance of a specific categories, while complexity is a direct dimension of the effort needed to develop the specific task. The proposed standardization allows to classified tasks and visualize which one are request for a specific job. Further studies should focus on building a detailed method of calculation for each dimension and describing tools and methods associated to the development of every category.

3.3 Knowledge

Knowledge is defined as all the information, acquired through experience and/or education, linked to a specific topic. In Table 2 a standard format is presented, defining which type of knowledge is necessary to perform a specific job.

Table 2: Standard knowledge categories

Macro category	Detail
Technical	Mechanics
	Construction
	Design
	Informatics
	Logistics
	Production and process
	Security
	Technology
	Telecommunications
Language	Foreign language
	Native language
Legal	Law
Management	Accounting
	Administration
	Business management
	Customer care
	Personnel Management
	Sale
Science	Biology
	Chemistry
	Economy
	Math
	Physic
Social and Psychological	Education and training
	Communication and media

3.4 Skill and Attitude

Skills and attitudes are defined as all the cognitive, physical, sensory and psychomotor characteristics of an individual that affect the performance of related task. In Table 3 a standard format is presented.

Table 3: Standard skill and attitude categories

Macro category	Detail
Cognitive skills	Understand
	Evaluate
	Communicate
	Think
	Create
	Manage
	Write
	Memorize
Sensory abilities	Sensorial-perceptive
	Visual
	Auditory
	Vocal
Physical abilities	Strength
	Resilience
	Dynamics
	Agility
Psychomotor abilities	Control
	Coordination
	Reactivity
	Precision
	Concentration

Differently from task's category both knowledge and skills and attitudes can be defined only through the "criticality" and "complexity" dimensions.

4. Application

In this section the results of the model's application on two different industrial types are discussed. Specifically, the aim of this section is to demonstrate how, through the application of the proposed model, it is possible to visualize the main characteristics of the specific industrial competencies. The visibility on the primary competency request for each industrial sector supports, on one hand, the feasibility study of the industrial development in a specific territory; on the other hand, addresses specific training. The textile and the food and beverage industries have been chosen for the application. Data are taken from the ISFOL's database and applied for the two industries. In this application the dimension of "complexity" for the task category has not been taken in consideration. The first industry that has been analysed is textile. As is it possible to see in the Figure 3, the model shows which are the task's category that has higher "criticality" and "frequence" values. For the textile industry, control tasks category results to have the higher criticality and frequence. This is an important finding in the understanding which are the core activities for the blue-collar's jobs.: specifically, "control activities" as controlling materials, quality of products, machines or process request specific knowledge and skills and, consequently, specific training. Moreover, results on knowledge category highlights that, for the blue-collar categories operating in the textile industry, it is more important to develop knowledge in "Production and process" field than others category. This is shown in Fig. 4.

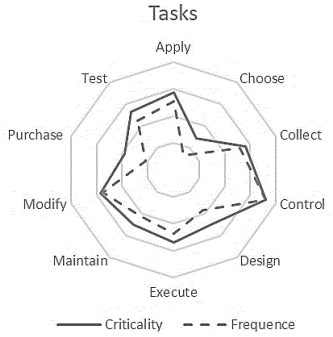

Figure 3: Task category for textile industry

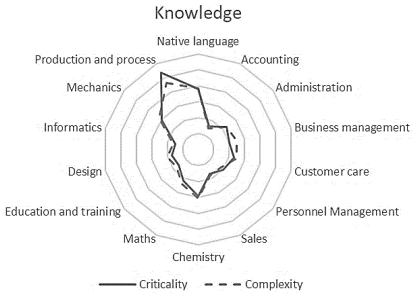

Figure 4: Knowledge category for textile industry

Lastly, in Figure 5 the results of the "skill & attitude" categories are summarized. This last graph shows the four different categories of skills and attitudes. From the results, for the textile industry the skills and attitudes linked to the following categories are needed:

- Communicate and memorize
- Precision and concentration
- Physical dynamism

Those categories are strictly linked with "control" activities and the analysis gives important indications about which attitude is important to be developed for this specific industry. For the food and beverage industry, the results of the task category – shown in Figure 6 – show two major findings: first, the number of task categories in this case is higher than the textile industry, demonstrating the higher variety of activities performed in the industry; then, the higher values are linked to:

- Apply: mainly applying procedure.
- Control: materials, quality of products, machines or processes.
- Modify: mainly modify / program / calibrate machines.
- Supervise and coordinate: department and team.

As well as for the case of textile industry, the emerging results give clear support for a further analysis on the competency needed for the blue-collar categories in food and beverage industry. Furthermore, the evaluation of the criticality and frequence of knowledge categories highlights which are the most important area to focus on. This is shown in Figure 7. Also in this case, a deep knowledge of

the process is request. At last, the analysis of skills and attitudes for the food and beverage industry, shown in Figure 8, reveals that there are several areas to focus on, such as physical dynamism and strength, or cognitive skills like attitude at memorizing and communicating.

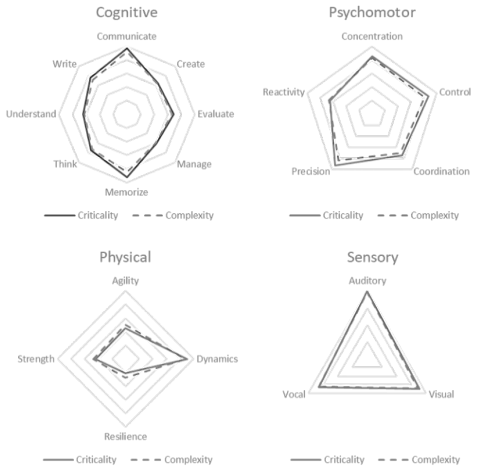

Figure 5: Skill and attitude category for textile industry

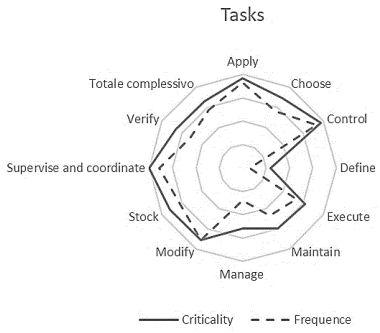

Figure 6: Task category for food and beverage industry

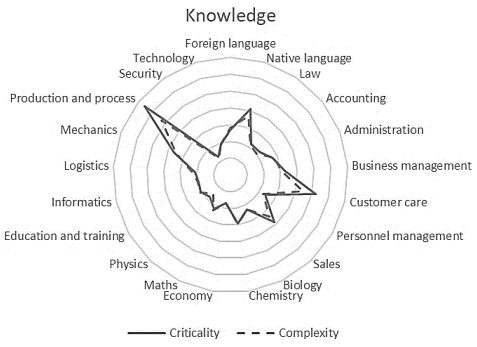

Figure 7: Knowledge category for food and beverage industry

5. Discussion

The success of an industrial settlement initiative in a foreign country is closely linked to the accuracy and reliability of the preliminary analysis of the target area. Specifically, the possibility of industrial development in emerging countries is often limited by the lack of some basic requirements, such as availability of water, electricity, lorry roads, as well as guarantees of personal safety or political stability. Investment opportunities are also complicated by the fact that low levels of education and cultural diversity make it difficult to find the specific skills required for direct labour. This research is the first step of an extended model, that aims to support companies in the initial study phases of industrial development in African countries.

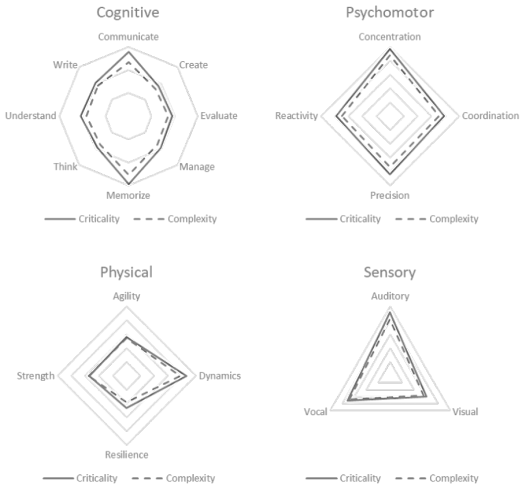

Figure 8: Skill and attitude category for food and beverage industry

Moreover, one of the major goals is to create a tool that can directly support the investors, giving a contribution to the governmental initiatives. Specifically, the main objective of the research is the development of a decision-making model capable of highlighting the most suitable areas for each specific industrial sector, providing important technical-economic indicators, as risk, compatibility, and sustainability values, guiding the investment in new industrial plants. These indications support investors, stakeholders of the framework, in developing their industrial business. The main benefit obtained by the model for investors is to have a quantitative tool that clearly guides new industrial settlement, consequently reducing the risk of failure. This tool should be considered as a strategic planning tool. In particular, the challenges that have been faced so far are the definitions of tasks, knowledge, and skill and attitudes macro-categories. This procedure allows developing a standard description of the competency needed for each job, specifying the "criticality", the "frequence", and the "complexity" of each part, in order to guide the analysis and the development of the workforce needed. Future studies shall investigate how to further detail the proposed competence model, extending the number of analysed industrial jobs . In addition, the definition of specific evaluation methodologies for every job category is advisable.

6. Conclusions

It is known that developing work capabilities in the industrial field is one of the key factors for launching a sustainable industrialization process, especially for underdeveloped countries. This research aims at proposing an effective model for supporting investors deciding to expand their business in an underdeveloped countries. This paper moves a first step in this direction, providing a useful contribution to the literature with a standard framework designed to analyse and develop competency inside industries. The authors choose to leverage on ISFOL database to link the workers' competencies to the specific

industry. The authors proposed a structure that describes the three main dimensions of a job, which are tasks, knowledge and skills and attitudes. Furthermore, several standard categories for these dimensions have been defined. In this way, the model:

- Provides a standard way to define individual's competency within an industry;
- Provides a clear view on which are the competency requirement of a specific industry;
- Provides the elements needed to understand which training has to be promoted to develop specific competence.

At the present state of the research some limitations can be highlighted. Specifically, the model could be deeper extended, both studying more categories and more dimensions. Another important point, that will be overcome in future work, is the possibility to measure all the presented categories. For these reasons this proposal shall be considered as a first step in this research stream. Moreover, in order to improve the usability of the framework, future research can focus on the industry characterisation from general resource requirements, and focus on the definition of which territorial-specific KPIs (e.g. level of education) can be used to better understand which industrial typology can be developed in each area, to effectively support investors.

References

African Development Bank-Group, (2017). *Industrialize Africa: Strategies, Policies, Institutions, and Financing.*

African Union Commission, (2017). *Action Plan for the* accelerated industrial development of Africa.

African Union Commission, (2015*). Agenda 2063: The Africa we want.*

Aregbeshola, R A., (2017). *Import substitution industrialisation and economic growth – Evidence from the group of BRICS countries,* Future Business Journal 3 (2017) 138–158.

Brautigam, D., Diao, X. & McMilla, M., (2017). *Chinese Investment in Africa: How Much Do We Know?* UKaid.

Deloitte, (2016). *Global Manufacturing Competitiveness index.*

Etzkowitz, H., (1995). *The Triple Helix -- University-Industry-Government Relations: A Laboratory for Knowledge Based Economic Development*. EASST.

Ficawoyi, D.A, Sokchea, L., (2018). *On the importance of Chinese investment in Africa,* Review of Development Finance 8 (2018) 63–73.

Haraguchi, N., Martorano, B. & Sanfilippo, M., (2019). *What factors drive successful industrialization? Evidence and implications for developing countries.* Structural Change and Economic Dynamics, Volume 49, pp. 266-276.

James, V., (1998). *Capacity Building in Developing Countries: Human and Environmental Dimensions.* Greenwood Publishing.

Joffe, A., Kaplan, D., (1995). *Improving manufacturing performance in South Africa: The report of the Industrial Strategy Project*, International Development Research Centre.

Johanson, R.K., (2004). *Skills development in Sub-Saharan Africa,* World Bank regional and sectoral studies.

Morris, M., Fessehaie, J., (2014). *The industrialisation challenge for Africa: Towards a commodities-based industrialisation path,* Journal of African Trade 1 (2014) 25–36.

OECD, (2008). *African Economic Outlook 2008*, African Development Bank.

Opoku, E. E. O., Yan, I. K.-M., (2019). *Industrialization as driver of sustainable economic growth in Africa.* Journal of International Trade & Economic Development, 28(1), pp. 30-56.

Osabutey, E. L., Nyuur, R.B., (2015). *Developing strategic international human resource capabilities in Sub-Saharan Africa.* Management and Industrial Engineering.

Peliwe, L., Ngcwangu, S., Jacinto, C., Millenaar, V., Martin, M.E., (2015). *Understanding Barriers to Accessing Skills Development and Employment for Youth in Argentina and South Africa: Synthesis Report.* Instituto de Desarollo Economico Y Social.

Rodrik, D., (2016). *An African Growth Miracle.* Journal of African Economies, 27(1), pp. 10-27.

Signé, L., Johson, C., (2018). *The potential of manufacturing and industrialization in Africa: Trends, opportunities, and strategies*, Africa Growth Initiative.

Stewart, F., Wangwe S., Sanjaya, L., (1992). *Alternative Development Strategies in Sub-saharan Africa.* Palgrave Macmillan UK.

United Nations Conference Trade and Development (UNCTAD), (2018). *World Investment report 2018*.

United Nations Industrial Development Organization (UNIDO), (2015). *Implementation of the Thirs Industrial Development Decade for Africa (2016-2025).*

United Nations Industrial Development Organization (UNIDO), (2016). *The role of technology and innovation in inclusive and sustainable industrial development*, Industrial Development Report.

United Nations Industrial Development Organization (UNIDO), (2017). *What Factors Drive Successful Industrialization? Evidence and implication for developing countries.*

United Nations, (2016). *Agenda 2030 per lo sviluppo sostenibile.*

Underdeveloped Countries Population. (2020-02-17). Retrieved 2020-02-02, from http://worldpopulationreview.com/countries/underdeveloped-countries/

World economic forum, (2018). *Reafiness for the future of production report 2018.* World Economic Forum's System Initiative on Shaping the Future of Production.

Yuan Sun, I., (2017). *The World's Next Great Manufacturing Center.* Harvard Business Review.