

Prospects for the aerospace industry in the Sudan

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Abstract

Purpose – The purpose of this paper is to investigate the contribution of the Sudanese manufacturing sector to the Sudanese economy and assess the role that aerospace industry, in particular, can play as a driver for achieving sustainable development in the Sudan.

Design/methodology/approach – This paper reviewed and analysed the contribution of the industrial sector to the Sudanese economy based on the comprehensive industrial survey carried out with the assistance of United Nations Industrial Development Organisation and United Nations Development Programme in 2001. It then went on to assess the role that aerospace industry can play in improving the contribution of this sector to the Sudanese and regional economy and achieving sustainable development. Evidence from global industrial views, international economic reports and experience of other countries in similar situation as the Sudan was used to support arguments.

Findings – The Sudanese economy is agriculturally based. A heavy injection of industrialisation of the economy is essential in order to improve the trade balance and help the country out of the poverty zone. The aerospace industry is an important ingredient of the required dose as the global and regional demand is high and the flourishing regional economy is encouraging. The paper argues that building a flourishing aerospace industry as an important element of sustainable development plan for the Sudan is a shared responsibility of good government, quality education and well-guided investment.

Practical implications – The paper is proposing a practical way to transform the character of the Sudanese economy and help it to set on a sustainable development path that will alleviate poverty and improve the standard of living of its citizens.

Originality/value – The paper gives critical assessment of the role of the industrial sector in driving the Sudanese economy, which is seriously lacking in the literature. Additionally, the paper introduces building a flourishing aerospace industry in the Sudan as an important ingredient to boost the manufacturing sector, hence, improve the economy, fight poverty and a step towards achieving sustainable development.

Keywords Sustainable development, Manufacturing, Aerospace, Sudan, Industry, National development plan

Paper type Technical paper

1. Introduction

The Sudanese economy can only be categorised as agricultural economy. The industrial base of the country is still at its infancy, although the increased discovery, extraction and economical exploitation of oil have increased the relative importance of this sector. However, the secession of the southern part of the country in 2011 (see map of Figure 1) carried away with it almost three quarters of the existing oil fields at the time, which were designated to the newly formed independent state of South Sudan, rendering this sector less prominent than it was for the Sudanese economy unless new discoveries and investment are urgently injected into it. Additionally, recent activities in the petroleum, motor vehicle and heavy machinery industries have covered only a small part of the local





Source: www.enoughproject.org/conflicts/sudans

Figure 1.
The map of
the Sudan and
South Sudan

market and are yet to make any contribution to the global market. As such, their impact on the economic structure of the country is hard to notice.

However, the Sudan is not unique in this unfortunate situation as many other developing countries, particularly in Africa, are yet to find a development path that takes them outside the poverty zone and opens the gates of sustainable development in front of them. The current global economic downturn may, ironically enough, present these countries with a golden opportunity to play some crucial role in recovering the required balance to the global market. This is because the biggest multinationals and industrial companies, feeling the pinch of the economic downturn, are now seeking refuge in exploiting resources and cheap labour well beyond their traditional market zones and exploring every opportunity to mitigate business risks and reduce their base costs through restructuring and off-loading cost to suppliers and strategic risk-sharing partners. However, in expanding globally, these companies would be looking for places with developed infrastructure, skilled labour and appealing investment opportunities.

The aerospace industry is one good example in hand for such global expansion. It is predicted that the air transport market will grow by about 5 per cent annually, generating an estimated demand of around 25,000 new aircraft for the next 15 years (Airbus, 2009; Statista, 2016). With this growth, there would be a huge pressure on airport capacity and control systems would be stretched as never before creating more opportunities for the aviation industry in general. This expansion will not be geographically limited as the market is growing globally and, consequently, creating more and more opportunities worldwide. As illustration to this, close to 90 per cent of the

components of Boeing's newly developed 787 aircraft were designed and manufactured outside the USA, whereas Airbus has recently opened a final assembly line for its single aisle A320 model in China. Similarly, Bombardier has invested \$200 million into Mexican manufacturing facilities that will produce wiring assemblies and major structural components (Pritchard and MacPherson, 2007). Indeed, there are currently more than 400 main aircraft component suppliers all over the world, including some developing countries (Dafa'Alla and Hussein, 2009a).

This paper discusses the major requirements for flourishing aerospace industry in the Sudan as a means of achieving sustainable development in the country, assess current obstacles and make recommendations for establishing one.

2. Aerospace industry: challenges and opportunities

Aerospace industry, like any other, has to respond to society's need, which is the prime driver for generating market interest in the first place. In fact, in an air transport system that must be more closely matched to the needs of customers and citizens, the cost and efficiency of the aircraft as well as its design and manufacturing must be the most competitive, particularly at the current global economic downturn, while meeting the sustainable development requirements of looking after the environment and taking the needs of future generations into account. To achieve this, aircraft may be acquiring new shapes and sizes by 2020 to improve the technical efficiency of the air transport system and raise their safety and environmental performance (European Commission, 2001). Flying wings could offer more efficient and quieter solutions, airships may finally establish themselves as a cheap alternative for carrying freight, and convenience flying could be a reality with tilting wings that allow vertical take-off and landings. The super-liners able to carry over 1,000 passengers may need new airport systems to handle them, folding wings to avoid occupying too much airport space, and enlarged and sophisticated entrances and exits that can handle the required fluency at terminals as well as proper evacuation in emergency situations. Therefore, the future is likely to see more competitive air designs with different configurations than the classic cylindrical fuselage with engines hanging from low wings in response to society's need for more affordable, safer, cleaner and quieter air transport. Blended wing body configuration is one example in hand (Dafa'Alla and Hussein, 2009a).

In the meantime, thanks to technology advances, today's aircraft will continue to be improved in aircraft design, production, manufacturing and maintenance as well as operation and traffic management. The digital revolution will also have vital impacts on flight systems while big strides in safety will be possible through human factors research and intelligent monitoring and control systems that will anticipate problems and take preventative actions even before the pilot is aware anything is going wrong (European Commission, 2001). Indeed, the application of emerging technologies had already transformed aircraft design and production over the last few decades. For example, the regular use of computer aided design by all major aircraft manufacturers to help the integrated design of the structure, the systems and the engines right from the first phases of conception has permitted huge reductions in production and manufacturing time and costs. Airbus had, for example, managed to shave off over two years of traditional development cycle time of its A350 model. This, together with the use of new generation of lighter materials which are corrosion resistant, tolerant of damage and repairable as often as necessary, lower operating and maintenance costs, better overall management of the aircraft and its use, has been instrumental for cheaper air travel. Additionally, there is also relentless demand for

every industry to reduce emissions and burn less fuel and these are goals the aerospace industry will continually strive for. In this context, research in new forms of environmentally friendly fuels to reduce, if not replace, the current dependency on the petroleum-based fuel is well abreast (Dafa'Alla and Hussein, 2009b).

This opens new challenges for the aerospace industry and, indeed, also brings with it new opportunities. Big research and technology programmes are well underway now both in Europe and the USA. Resources were allocated to implement the ACARE 2020 vision, which shapes the European stakeholders vision to meet the challenges for the aerospace industry up to the year 2020 (Dafa'Alla and Hussein, 2009b). There are also currently collaborative research programmes between Airbus and China or South Africa, to name but a few. Additionally, major manufacturers, such as Boeing and Airbus, have just finished restructuring programmes, reorganising their companies, bringing in risk-sharing partners and positioning themselves to respond to these challenges in a timely manner. In the wake of this, new opportunities were created in research, development, design and production lines worldwide (Dafa'Alla and Hussein, 2009b). And, it seems that more and more developing countries are, quite rightly, taking advantage of this. For example, Iran has recently joint forces with the Ukraine to build its own aircraft industry; Morocco announced a big investment programme to initiate aircraft components industry; United Arab Emirates started a huge partnership programme with Airbus aimed at developing education, training, maintenance and manufacturing base in the country while Qatar has started a collaborative aerospace research programme with international partners. Likewise, it was also announced more recently by Airbus at Dubai Airshow that five A330 aircraft ordered by Saudi Arabia would be converted into Multi-Role Tankers in Riyadh in partnership with a yet-to-be-selected local partner. Jeddah had been under consideration as the location for the in-country modification centre (Doyle, 2009). These activities show that, in principle, the developing world can, and indeed should, take advantage of these newly founded opportunities in order to play its full part in the global world economy. They also show the important role of the aerospace industry in diversifying economy and creating new employment opportunities to boost the local economy. Challenges might be there, but if there is a will, there is a way.

3. The case for the Sudan

3.1 Overview of the manufacturing sector in the Sudan

3.1.1 Sudanese manufacturing landscape. The manufacturing sector in the Sudan is very small in size and mainly dominated by small-scale industries. Historically, large-scale industrial establishments were limited to the manufacturing of food products and beverages and, with an approximate share of 55 per cent of the gross manufacturing output and 56 per cent of the manufacturing employment, this category still represents the main activity of the Sudanese manufacturing sector (Dissman, 2004). The sugar production and grain mills are the main activities in this category followed by vegetable oil. The Kenana Sugar Factory was built in 1976 to add to the older three factories in Gunaid, Khashm Elqirba and Maloot and gave a real boost to the manufacturing sector in general and the food and beverages category in particular. With an annual production capacity of over 400,000 tonnes of white sugar in addition to molasses, dairy products, animal feeds and more recently (June 2009) Ethanol as biofuel, Kenana is currently the largest integrated sugar company in the world (Kenana, 2016). Additional two factories in Asalaya and Sinnar were added later on to make the Sudan the second largest sugar producer in the African continent after the

Republic of South Africa. On the other hand, the 1960s and 1970s witnessed the flourishing of the large-scale textile industry with the Sudanese Textiles Factory in Khartoum North, owned by the International Gulf Establishment, reaching the peak of its production. Unfortunately this factory was forced to shut down due to unreliable power supply on the one hand and disruptive industrial relationship between the workforce unions and management on the other.

However, the last two decades have witnessed a big injection to the heavy industry in the Sudan with the introduction of the manufacturing of heavy military and civil machinery, motor vehicle industry and significant expansion in the petroleum industry from extraction to refinery. Most notably is the construction of the Khartoum Refinery Company (KRC) with a total output capacity of five million tonnes per year. The refinery started production in May 2000 to process Sudanese indigenous crude oil to cover the need of the Sudan for petroleum products (Khartoum Refinery Company, 2014). Needless to say, the recent secession of South Sudan in 2011 has interrupted the flow of crude oil to the refinery and hence set back its ambitious targets. Therefore, a new strategy to define the future place of KRC in the industrial map of the Sudan is urgently required. More recently, the Sudan has also entered the field of aerospace industry by building the Safat centre for the maintenance and manufacture of lightweight aircraft in Karari. It is interesting that, apart from the petroleum industry, all these new additions were established under the auspices of the military establishment and fully controlled by the military industrial administration of the Armed Forces. Perhaps the logic at the time was that the military establishment was the only qualified institution to lead and manage such huge projects in a country like the Sudan. However, the success of the petroleum industry, which was fully controlled by the ministry of energy, falsifies this assumption. Anyway, despite adding more than 15 per cent to the manufacturing contribution to the gross domestic product (GDP), these recent additions to the industrial sector have so far contributed only 3 per cent to the overall manufacturing employment (Dissman, 2004). Nevertheless, they rank among the best in terms of compensation for employees, such as wages, supplements and social benefits, etc. Therefore, though a step in the right direction, their full impact on the whole economy is yet to be felt.

A comprehensive national survey was conducted in 2001 by the ministry of industry with support from the United Nations Industrial Development Organisation (UNIDO) and United Nations Development Programme (UNDP). The report on its findings (Dissman, 2004), was published in November 2004. It is the most comprehensive survey of the Sudanese manufacturing sector to date and was an excellent opportunity to gather the much-needed information on the Sudanese industrial sector. Hence, unless otherwise stated, the report has been used as a source of the industrial statistical data quoted in this paper. The survey covered 24,114 small (of less than ten employees) and large (of ten or more employees) industrial establishments employing 162,682 persons and spread throughout the country covering 19 out of the 26 states of the Sudan before the secession of South Sudan. As the survey covered the whole Sudan before secession (see Figure 1), the figures quoted herein were adjusted as appropriate in order to reflect the reality of the Sudan today. However, it was noted that the contribution of the three states that formed the new South Sudan, namely Equatoria, Bahr-el-Gazal and Upper Nile, in the overall number of industrial establishments was less than 2 per cent (see Figure 2), 97 per cent of them are small-scale industries, mainly in the food and beverages or clothing sectors. Their combined contribution to the overall GDP was around 1 per cent. This contribution was found to have little impact on the overall

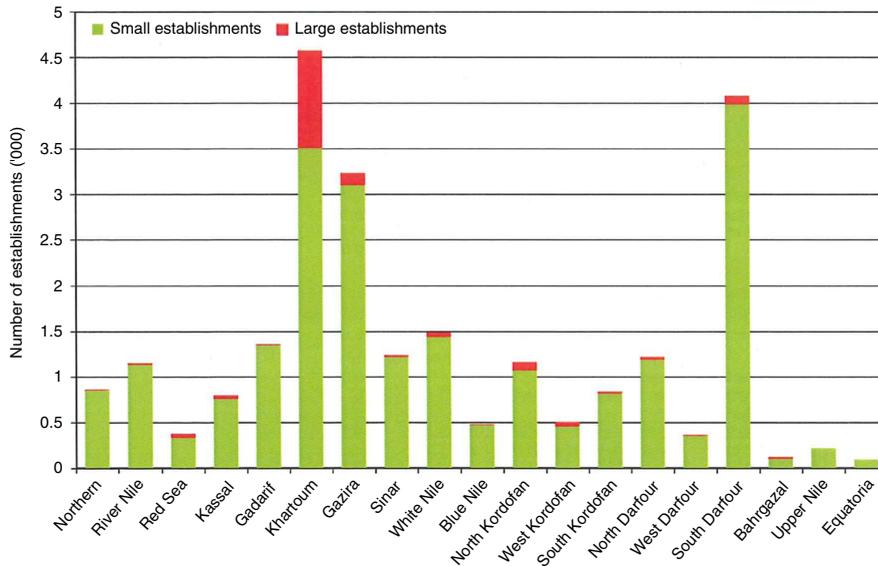


Figure 2.
Sudanese
manufacturing
landscape

Source: Adapted from Dissman (2004)

percentages quoted in Dissman (2004). The petroleum industry was the exception as 42 per cent of its establishments are located in the state of the Upper Nile alone. It has a significant effect on GDP and one of only two industries that have a positive trade balance. Note that the statistics pertinent to South Sudan were also reported in this paper where relevant in order to help academics and researchers in the field, who will continue to rely on data coming from the North, i.e. the Sudan, to address issues pertinent to South Sudan until the time comes when the official statistics institutions in South Sudan are well established and fully functional. However, in order to handle the huge volume of the gathered data and facilitate reporting, the 2001 survey also classified the manufacturing establishments in 22 categories following the international standard for industrial classification of all economic activities as defined in United Nations (1989). These categories are shown in Table I. Figure 2 shows the geographical distribution of the manufacturing establishments included in the survey. The figure shows that the largest three states in terms of the number of industrial establishments, both in the small and large-scale categories, are Khartoum, South Darfour and Gazira states, respectively. These three states have the lion's share as each of them has more than double the number of industrial establishments in any other individual state.

3.1.2 Contribution to the Sudanese Economy. The value added per capita of the Sudanese manufacturing sector, which is a measure of the contribution of the industry to the GDP, is only \$89.92 according to the 2012 industrial statistics published by NationMaster (2012). This is very small relative, for example, to the corresponding average of the G7 countries of \$5,289.76 per capita and hence ranked the Sudan as number 147 out of the published 187 countries in the world. The Sudan, therefore, ranks in the group of "countries with low industrial production" and can be seen as a mainly agriculturally based economy. In fact, according to the comprehensive industrial survey of 2001, the total manufacturing share in the Sudanese GDP is only

Table I.
The Sudanese
manufacturing sector
classification as used
in Dissman (2004)

S No.	Category
1	Manufacture of food products and beverages
2	Manufacture of tobacco products
3	Manufacture of textiles
4	Manufacture of wearing apparel; dressing and dyeing of fur
5	Tanning and dressing of leather, manufacture of leather products and footwear
6	Manufacture of wood, cork, plaiting and related products, excluding furniture
7	Manufacture of paper and paper products
8	Publishing, printing and reproduction of recorded media
9	Manufacture of coke, refined petroleum products and nuclear fuel
10	Manufacture of chemicals and chemical products
11	Manufacture of rubber and plastics products
12	Manufacture of other non-metallic mineral products
13	Manufacture of basic metals
14	Manufacture of fabricated metal products, excluding machinery and equipment
15	Manufacture of machinery and equipment (not exclusive category)
16	Manufacture of office, accounting and computing machinery
17	Manufacture of electrical machinery and apparatus (not exclusive category)
18	Manufacture of radio, TV and communication equipment and apparatus
19	Manufacture of medical, precision and optical instruments, watches and clocks
20	Manufacture of motor vehicles, trailers and semi-trailers
21	Manufacture of other transport equipment
22	Manufacture of furniture, manufacturing (not exclusive category)

9.5 per cent, of which 1 per cent was contributed by the southern states (Dissman, 2004), confirming a relatively low importance in the Sudanese economy. The survey also showed that the agro-food industry, dominated by sugar production and grain mills, is the biggest contributor to the GDP with a share of 6.1 per cent. The next largest sector in output is the relatively young petroleum industry, contributing 1.1 per cent albeit being relatively small employer. This is now largely assigned to the new state of South Sudan. The other sectors add very little to the GDP. This is in line with the small contribution of 1.7 per cent of the manufacturing sector to the overall employment market of 9.7 million employees, only 0.01 per cent of them work for the petroleum industry. However, it is interesting that the petroleum sector has a very low percentage of manufacturing employment (0.5 per cent) but, at the same time, is the second largest contributor in terms of the value added (11 per cent) relative to the total manufacturing sector. This indicates a capital-intensive industry. On the other hand, with a cost that is four times its output, the category of manufacture of medical appliances and supplies is the only category that shows negative value added per capita and appears to be in some trouble. Generally, most of the value added comes from the largest establishments of more than 100 employees, which contributes 68 per cent of the total manufacturing value added per capita. The small-scale establishments of less than ten employees contribute only 16 per cent (Dissman, 2004).

Additionally, the Sudan's manufacturing industry is not very much exposed to export. Its export share in total merchandise exports is only 12.8 per cent, with only 11 out of the 82 manufacturing sub-categories involved in export activity. Also, most of the exports are raw materials. No higher value chain – reflecting industry's weakness. The bulk of manufacturing exports (87.3 per cent) comes from two main players, the sugar industry with 45.7 per cent and the petroleum industry with 41.7 per cent.

This explains the down effect of the secession of the south on the Sudanese economy that has suddenly lost the majority of its petroleum export value. The only exporting industry in the group of small establishments is the vegetable oil producers with 0.1 per cent of the total manufacturing exports. In fact, while the small-scale industry represents 93.14 per cent of the total number of the Sudanese manufacturing establishments and employs 40 per cent of the total manufacturing force, it produces only 18 per cent of the manufacturing gross output. This shows that small-scale industry can indeed contribute significantly to the local economy, but is not yet a suitable driver to fund national development plans. Nevertheless, a strategic push towards small-scale industry is important in order to uplift rural economy and halt migration from rural to urban districts, which is now galloping at an estimated annual rate of 2.6 per cent (Index Mundi, 2016).

On the other hand, opposite to exports, the Sudanese industry is much more dependent on imports. The share of manufactured imports of the industry in total merchandise imports is 21.2 per cent. The biggest contributors to this figure are the food production, motor vehicle assembly and the chemical industry, with shares of 47, 17 and 10 per cent, respectively. The petroleum industry imports only about 0.3 per cent. These percentages only take into account the direct imports of the manufacturing industry. If the indirect imports, which enter as raw materials and semi-finished goods through other sectors of the economy, were taken into account, the real import content of the manufacturing sector is expected to be even higher. Hence, when the net contribution of manufacturing sector to the economy of 21.2 per cent of imports and 12.8 per cent of exports is considered, the net effect on the trade balance would be negative by about \$200 million. The only two categories that have a comparative advantage to the trade balance are the leather and petroleum industries. Deducting the 3.2 per cent of the trade balance share coming from the petroleum industry will increase the negative trade balance even further. In fact, apart from the leather industry, which represents 0.6 per cent of the exports share, the petroleum industry was the only other industry that has a positive trade balance. The motor vehicle industry, on the other hand, has the most negative contribution to the trade balance of -1.4 per cent. This industry seems to be disadvantaged relative to other categories because it has one of the highest import content in intermediate inputs to production. However, it has an indirect positive effect on the economy as a whole by satisfying some of the local demand, and hence reducing the need for importing more vehicles, as well as contributing to the employment market. Yet, a bigger impact on the economy would have been more visible if it could manage to export its product. However, this will require more local component manufacture to address industry's trade imbalance, less protectionism, improved management, lean practices and aggressive marketing techniques.

3.1.3 Employment and labour satisfaction. It is worth noting that the Sudanese manufacturing average labour compensation per employee, such as wages, supplements, benefits, etc., for 2001 was about \$1,400. This average value has an upwards bias due to the exceptionally high averages for the petroleum and tobacco industries, which stand well above the others at 18.44 and 3.02 times the total manufacturing average, respectively. Excluding these two categories, the overall average will come down to \$1,200 or less than \$0.5 per hour. This is extremely low when compared to the value of \$23.15 per hour of the US civil employee in 2002, a reasonably close time to the Sudanese national survey reported by High Beam (2002). Likewise, the industrial average share of compensation of employees in value adding of

14.1 per cent is low, while the material intensity of total manufacturing of 56.2 per cent is relatively high. These figures indicate cheap labour and material intensive production. On the one hand, the figures are good news to investors as the average cost of labour to the industry is low. Indeed, the total manufacturing labour cost is only 6.2 per cent of the gross output on average, while the average rate of return on investment in fixed assets is as high as 8.5. This means that the return rate is nearly nine times the done investment. A very rewarding value, indeed! On the other hand, the figures could also be interpreted as that manufacturing sector may not be that rewarding for its employees. And, the low average share of supplements to wages and salaries in employees' compensation of 5.5 per cent does not help improving the low morale resulting from low wages either. The fact that the highest labour productivity is in the high-waged petroleum industry reinforces this view. However, it should be emphasised that the high productivity of the capital-intensive petroleum industry is a reflection of a combination of high wages, high oil prices, material intensity, modern technology and good management. Interestingly, tobacco industry (private sector) is among the largest in average labour compensation while ranks at the tenth position in the manufacturing sector with a contribution of not more than 0.14 per cent to the GDP. This large labour compensation is not surprising considering the rate of return on investment of 1,487.12 of the tobacco industry, which is the largest by far among the whole Sudanese manufacturing sector. This, in turn, also explains the private sector interest in this industry and reflects the lack of strategic direction in the absence of appropriate state monitoring of the overall economy. It is also interesting to note that the public sector pays the largest compensation per employee in the large establishments sphere followed by mixed public and foreign ownership. The private Sudanese with foreign partners and the pure Sudanese private sector come third and fourth, respectively, while the pure private foreign ownership lies at the bottom of the list. This shows that safeguarding employees' interests requires a level of public "policing" or monitoring of foreign investment.

3.2 Review of aerospace industry in the Sudan

It is fair to say that aerospace industry is virtually non-existent in the Sudan until recently. In fact, the 2001 national comprehensive survey findings show very little, if any, industrial activity in the category of transport other than motor vehicle industry (Dissman, 2004). Historically, there is only low-level lightweight aircraft maintenance activity locally. All major aircraft overhaul for transport aircraft was carried out abroad. However, the aerospace industry has experienced a face-lifting operation in 2009 by the opening of the Safat aviation complex. The complex was meant to house facilities for the maintenance and overhaul of different types of aircraft including civil and military fixed wing and helicopter aircraft as well as a directorate for aircraft manufacturing and development (Safat, 2009). As such, the centre is now carrying out periodic maintenance work for up to 1,800 hours of flying. This covers most of the urgent needs of lightweight and Antonov aircraft in addition to the military helicopters and fighters. On the manufacturing side, the complex has managed to build a light aircraft, Safat 01, exploiting local capabilities in 2009. This was more of a "proof of concept" than a serious economical project. However, since then there are another two ongoing projects for the production of a light multi-purpose helicopter, Safat 02, and a training aircraft, Safat 03 (Safat, 2014). The group has recently formed a number of partnerships with some African countries for helicopters' overhaul as well as

maintaining a number of companies operating Antonov aircraft in Congo and Angola. It is currently providing services in more than seven African countries and has plans to cover more than 15 African countries. The long-term strategic direction is to get into the unmanned air vehicles (UAV) market. The ambition is to be the top in aviation industry nationally and continentally through provision of high-quality products with reasonable prices to satisfy their clients and contribute to the lifelong development of the industry (Safat, 2014).

3.3 Discussion

To get out of the poverty zone, the Sudan needs to adopt an integrated sustainable development plan, in which industry represents the pivotal point. The above analysis shows that the Sudan is still far away from having an effective industrial sector. Recall that all the developing countries that managed to get out of the poverty trap and significantly improved the standard of living of their citizens such as the South-East Asian countries have adopted a clear industrialisation path as part of their development models. The Sudan will not be the exception. Therefore, the present industrial output of 8.5 per cent of the GDP is not enough and a big dose of heavy industry is required. Although the aerospace industry is not the panacea by itself, yet it can be one effective element of the anticipated dose.

As shown above, the global demand of about 25,000 aircraft over the next 15 years is high. More reassuringly, the African air traffic is expected to grow above the world average at a rate of 5.6 per cent annually for the next ten years owing to its central geographical location between America, Europe and Asia combined with growing regional economy and flourishing trade and tourism (Airbus, 2009). Also, the African continent economy, against all the odds, is growing. In fact, despite the current world recession, Africa is still expected to enjoy an average of over 4 per cent real GDP growth per year over the next few years, compared with 3 per cent average annual growth for the world as a whole (World Bank, 2016). Therefore, the regional demand, where the Sudan can, in principle, play a role, will remain strong.

Regionally, one can predict an increase in demand for light and short-range aircraft for agricultural applications and internal or regional travel. Also, with increasing air traffic within and over Africa, the demand on approved maintenance centres for large air transport aircraft is self-evident. The Republic of South Africa is the only country in the continent to have a centre for major overhaul of this type of aircraft at present. Additionally, a US study estimates there may be as many as 5,000 microjets employed by on-demand air taxi services by 2010 and 13,500 by 2022, so microjets alone could represent 40 per cent of daily operations by 2025 (Rolls Royce, 2004). New vehicle types, such as UAV, would push this percentage even higher. There is no capacity in the world to meet this demand at present. Also, as argued above, the globalisation of the aerospace industry is driving major players to seek partners where the labour cost of manufacturing is relatively cheap. Research is another area, which is going global in order to reduce cost and fully utilise the global pool of talented researchers and academics. There is a real chance for the developing countries to complement or join such activities and benefit from training and technology transfer opportunities. Developing countries, such as the Sudan, should actively seek to maximise their gain of such opportunities. This can be achieved by developing their own capability and improve quality to be considered as preferred suppliers for targeted components manufacture, if not risk-sharing partners.

The Sudan may find a lot of comfort in the success of the South-East Asian development model, which the Sudan is aspired to replicate some of its aspects.

However, the model stands on the four pillars of quality education, self-reliance, heavy industrialisation and good governance. And, for it to succeed, it needs to be transferred to other countries as a package. The Sudan has a good experience with self-reliance in developing its own motor vehicle and petroleum industries. However, a comprehensive national industrial development plan is still sketchy. Quality education and good governance, on the other hand, are real concerns for the whole of Africa as shown by Dafa'Alla *et al.* (2016a, b). Indeed, Dafa'Alla *et al.* (2016a, b) have identified quality education as the root cause of the lack of development not only in the Sudan but Africa in general. They presented strong correlation between accessibility to and quality of education system on the one side and sustainable development indicators, such as human development, ability to innovate and economic competitiveness on the other and concluded that education that builds capacity and fosters innovation is a means to catching up with lost opportunities, building an “innovation-based economy” and realising the African dream. Likewise Dafa'Alla and Hussein (2009b) argued that the main barriers to the implementation of any national development plan in Africa would be the corruption, political instability and lack of investment. In fact, tackling these three issues is a prerequisite for economic success, as attracting investment requires political stability with a strong anti-corruption drive. It is therefore not surprising that the leading South-East Asian countries, Singapore, Taiwan and South Korea, have all scored more than 50, the mid-point of the Corruption Perception Index (CPI) of 2014 published by Transparency International (2014). Indeed, with an impressive score of 84 out of 100, Singapore stands tall at number seven in the world.

The Economist noted that Africa's economy has grown much faster since 2000, but fears regarding corruption have risen too (Economist Intelligence Unit ViewsWire, 2008). Likewise, Transparency International noted that 20 out of the 48 (41.7 per cent) Sub-Saharan countries ranked in its CPI2014 survey scored less than 30 out of 100, a level that, according to Transparency International, indicates “rampant corruption”. Another 23 scored between 30 and 50, indicating that country's experts and businessmen perceived corruption as a “serious challenge” (Transparency International, 2014). Only four countries, Botswana, Cape Verde, Seychelles and Mauritius, scored more than 50. With a score of 11 out of 100, the Sudan was ranked at 173, the second from bottom, followed by North Korea and Somalia, who, at 174, were the joint least ranked countries in the world and both of them have their own substantial internal problems. With a score of 15 out of 100 and ranked at 171, South Sudan is not much better than the Sudan either. The two countries were only separated by Afghanistan, which was ranked 172. Using the four indicators of safety and rule of the law, participation and human rights, sustainable economic opportunity and human development, the more specific Ibrahim Index of African Governance (IIAG) for 2009 ranks the Sudan at 49 relative to the 53 countries in Africa, followed by the democratic Republic of Congo, Zimbabwe, Chad and Somalia, respectively (Ibrahim, 2009). Note that, following the secession of South Sudan in 2011, the Sudan was suspended from the IIAG until comprehensive data for both the Sudan and South Sudan are available; hence no more recent IIAG data for the Sudan is available to report herein. It is also noticeable that all countries that scored below 25 out of 100 in the CPI2014 or below 40 out of 100 in the IIAG2014 have identifiable internal political, social or economical problems, indicating a strong positive correlation between internal conflicts, good governance and public satisfaction on the one hand and corruption and human right abuses on the other. It should, also, be reiterated here that one should not dismiss such widely available information in the

public domain out of hand, as it is instrumental in shaping the world's perception of the country and hence influence the flow of foreign investment.

Finally, aerospace industry is a highly technological as well as capital and labour intensive industry. Therefore, flourishing aerospace industry requires supportive efficient infrastructure and good quality education. These, together with securing a renewable, clean and environmentally friendly source of energy, represent a prerequisite for sustainable development. Once they are in place, aerospace industry will help the Sudan to diversify its economy, create job opportunities and should, therefore, play its role in putting the country on course towards achieving sustainable development.

4. Recommendations

- An injection of heavy industrialisation to the Sudanese economy, with particular focus on higher value chain products for export, is required in order to improve the trade balance and lift the country out of the poverty zone. Aerospace industry is one key element of this dose, but by no means the only one.
- From economics viewpoint, good governance is required in order to establish the correct path for sustainable development, draw effective national plans and legislate for supportive policies and regulations to monitor and guide fair and strategic public and foreign investments as recommended in the "Employment and Labour Satisfaction" Section 3.1.3. However, regulation is only one of the means by which the society ensures that its values and priorities are reflected in the national development plan. It is equally important for investors to see the implementation of these regulations in practice before they have full confidence in the system. This means achieving political stability and creating a true investment-attractive climate.
- Additionally, the aerospace is a high technology and capital-intensive industry. And, for the Sudan to gain the required expertise, it needs to gradually, but steadily, build its capacity, embark on heavy investment in building infrastructure, technology transfer, training initiatives as well as securing the right environment for sustainable development that allows local talent to flourish and contribute towards building real aerospace industry in the Sudan. This requires a complete overhaul and upgrade of the current facilities and a fresh look at the bases of establishing new ones. Safat aviation complex is well positioned to lead this exercise. However, it seems that although the strategic direction of Safat is clear, the economic path is a bit murky due to both financial and political reasons.
- It is worth noting here that training is key in technology transfer and is seriously lacking in the developing world. In the Sudan, there are currently only two out of 26 universities that offer a specialised degree course in aeronautical engineering. These are The Sudan University of Science and Technology and Karari Military University. As a result, there is still a huge gap between demand and supply for such courses to support expansion in the aerospace industry. Also, and more importantly here, a strong drive towards education quality, rather than quantity, is required to support sustainable development in general and industry in particular. These could only be achieved through high-quality education and rigorous training to improve skills and nurture innovation. Recall that investment in people and in technological learning empowers the ability of the

society to sustain development through the creation of new knowledge and diffusion of appropriate technologies, which are important determinants for building capacity to sustain development (Al-Roubaie, 2013). Simply, as Dafa'Alla *et al.* (2015, 2016a, b) argued, quality education is the basis for all forms of development, not just aerospace industry, and the key to building “innovation-based economy”.

- Also, in order to meet tough industrial requirements, technical education should pay special attention to all levels of training, from vocational training for skilled labour to middle ranked technicians through to engineers. Training for management and marketing staff is also equally important. Remember, as Brace *et al.* (1999) put it, technology cannot be contained in a machine or a piece of software, it has an element of motivation and personal “know how”. Likewise, technology does not automatically yield innovation; imagination and first class marketing skills are also required.
- Additionally, customers today are quite knowledgeable and extremely demanding. They insist on independent verification of the product’s quality and supplier’s credentials. To satisfy these requirements, industrial establishments have to encourage their staff to obtain internationally recognised professional qualification, such as Chartered Engineer status offered by the British Engineering Council or European Engineer offered by the Federation of the European National Engineering Associations or any other equivalent internationally recognised award. There are also equivalent qualifications for technicians and skilled labour. For the Sudan, this should be a priority before launching its own brand.
- Finally, regular appearance at international stages, such as air shows and international conferences, raises the Sudanese aerospace industrial profile, highlights capability and improves networking. This, in turn, attracts foreign investment and improves the chances of collaboration with global industrial players.

5. Conclusions

Despite the recent additions in the fields of heavy machinery, motor vehicle assembly and oil industry, the Sudanese economy can only be described as agriculturally based. The industrial contribution of 8.5 per cent to the GDP and 1.7 per cent to the employment market is significantly small. A heavy injection of industrialisation of the economy is essential in order to improve the trade balance and help the country out of the poverty zone. The aerospace industry is an important ingredient of the required dose.

The high international demand for air transport and improving regional economy make the case for a flourishing aerospace industry in the Sudan. Yet, this industry is currently virtually non-existent in the Sudan. However, the recent opening of the Safat aviation complex has raised its profile. Though a step in the right direction, Safat is still a project in progress and its real impact on the Sudanese economy and society is yet to be felt.

Flourishing industrial sector in the Sudan requires clear development plan, good governance, supporting legislations, creating a true investment climate in the country and securing the right environment for sustainable development including renewable, clean and environmentally friendly source of energy. Additionally, building a high technology industry, such as the aerospace industry, requires heavy investment in infrastructure, technology transfer and training.

The education system and institutions should play a key role in providing the right quality of education and training to meet the aerospace industrial requirements at all levels from skilled labour and technicians through to engineers, marketing personnel and managers. External training and international qualification are also important to satisfy customer's requirements of independent verification of product's quality and supplier's credentials.

In summary, this paper argues that, building a flourishing aerospace industry in the Sudan to complement its sustainable development ambition is a shared responsibility of good governance, quality education and well-guided investment.

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Further reading

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