Private Sector Federation
(PSF- Rwanda)

FINAL REPORT

SKILLS ASSESSMENT: MANUFACTURING SECTOR

Kigali, March 2022

PREFACE

By PSF.

LIST OF ABBREVIATIONS AND ACRONYMS

AGOA	African Growth and Opportunity Act
CAD	Computer-Aided Design
CAT	Computer Automated Technologies
CNC	Computer Numerical Control
DMRS	Domestic Market Recapturing Strategy
EAC	East African Community
EDPRS	Economic Development and Poverty Reduction Strategy
GDP	Gross Domestic Product
ICT	Information, Communication and Technology
IGC	International Growth Centre
MINEDUC	Ministry of Education
MIR	Made in Rwanda
MRP	Material Requirements Planning
NISR	National Institute of Statistics of Rwanda
NSDEPS	National Skills Development and Employment Promotion Strategy
NST	National Strategy for Transformation
PSF	Private Sector Federation
R&D	Research and Development
REU	Rwanda Economic Update
SEZ	Specific Economic Zone
SMEs	Small and Medium Enterprises
STEM	Science, Technology, Engineering, and Mathematics
TQM	Total Quality Management
UNCTAD	United Nation Conference and Trade
USD	United States Dollar
WTO	World Trade Organization
$	Dollar
&	And

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EXECUTIVE SUMMARY

This Report presents the findings of the Skills assessment of the Manufacturing sector in Rwanda. The Assessment was commissioned by Private Sector Federation (PSF) as sector specific skills assessment targeting 10 sectors including Manufacturing sector. The main objective was to identify the skills required by the sector and assess the potential gap between the skills available in the manufacturing workforce and those demanded by the sector, leading to relevant suggestions for updating the education and training provision. The assessment focused on current manufacturing sector performance, skills status, skills supply and required skills for the industry's predicted performance. The assessment examines the magnitude of the skills mismatch, the drivers of change and their skills implications, and the future skills needs of the manufacturing sector. The report also points out areas to be prioritized for action in the short, medium and long term.

For the methodology aspect of the assessment, to have a sound understanding thoroughly reviewed existing information on assessing the skills requirements. The review analysis entailed understanding the policy and structural framework under which enterprises in Rwanda operate. Key secondary data sources also include the Skills Survey, Labour Force Survey, Skills Assessment, Country Report, and relevant research and policy analysis. Findings from the desk research helped to:

(1) Map out the current skills in manufacturing industry
(2) Identify the key skills gaps and explore ways to bridge those gaps
(3) Develop an understanding of strengths of challenges and policy gaps to be further examined.

Findings from the desk research were supplemented and validated through industry stakeholder consultations, and face-to-face interviews. Data underpinning the main issues were collected through a quantitative survey that was implemented via a field survey and online interviews. The Manufacturing skills in Rwanda was assessed both qualitatively and quantitatively from Manufacturing enterprises categorized as micro, SME, and large enterprises, and grouped based on the number of employees. The sampled manufacturing firms are characterised by gradual diversification from basic manufacturing to more value-adding activities in other sub-sectors that include:

(1) Fast-moving consumer goods such as detergents, body care products, paper tissues, plastic goods, papers, chemicals, beverages, textiles, leather and footwear, and cosmetics;
(2) Construction materials such as granite tiles, cement, roofing sheets, and tiles and steel bars and light items;
(3) Furniture laboratory equipment and;
(4) Electronic & automotive manufactured goods such as phones, computers, and vehicle assembly.

Data and information collected were reviewed, analyzed, and interpreted to summarize key findings and provide recommendations accordingly. The assessment found out that the manufacturing industry is fundamental driver in achieving long-term economic growth and generating higher incomes and contributed about 17 % to the country's GDP[1] in 2019. Growth in manufacturing was robust in wood, paper, and printing, where output expanded by 50 %, while non-metallic mineral products grew 38.5 %, chemicals, rubber & plastic products grew 25 %, and metal products, machinery, and equipment expanded 17.2 %[2]. In term of employment opportunities, the report shows that approximately 208,956 people were employed in manufacturing in 2019, accounting for 6.4 % of total formal employment. The branch of economic activity with the next highest number of employed persons was traded (14.8 %), followed by construction (9.6 %).

[1] http://rdb.rw/export/export/products-directory/manufacturing-sector/
[2] World Bank Group, Rwanda Economic Update,2020

The report maps out the skills required to work across the four occupational levels (manager/specialist, professional, technician and artisan), and at different stages in the product life cycle from small-scale production to the move to mass production in manufacturing industry. All of the evidence reveals that the manufacturing industry is facing skills deficiencies in crucial manufacturing jobs at professional, technician and artisan levels. These gaps curtail rapid expansion, limits the variety and quantity of output the companies can produce, results to inefficient production due to employing less qualified staff and hiring expatriates which significantly increases the cost of production especially in the textiles, clothing and leather sub-sector and in electronic & automotive manufactured goods such as phones, computers, and vehicle assembly. The assessment also shows that the manufacturing firms are providing inadequate training to their employees. As result, the skills gaps limit Rwanda's competitiveness and reduce economic and social development potential.
The report focuses on a critical concern for policymakers in recent years, skill mismatch in Rwanda mainly in manufacturing value chain comprising of production, distribution, sales and marketing, R&D, and technological innovation. The Report highlights the quality and market-relevant skills to build a competitive manufacturing industry. From a labour market perspective, potential future employment opportunities in the manufacturing industry have been highlighted in this assessment.

The evidence points to skills supply being well supported by an extensive initial and continuing vocational education and training infrastructure with a substantial increase in the number of people being qualified in the subjects and skills upon which the manufacturing sector is dependent. The SSA report indicate how provision of vocational training leads to improvements in company performance as well as generating a wider set of benefits relating to, for instance, the satisfaction employees derive from their employment.
The report points out the initiatives undertaken by the Government to respond to the skills deficits by investing heavily in technical education and skills training, mainly in STEM education and infrastructure. The assessment found that a number of higher education institutes have specific expertise or Centres dedicated to manufacturing, for example the Biomedical Engineering and E-health in University of Rwanda; the Food Science and Technology Research Centre in College of Science and Technology (CST); the Centre of excellence in Innovative Teaching and Learning mathematics and science in College of Education; Centre of Excellence in Internet of Things; and National Industrial Research and Development Agency offering an array of support services aimed at improving the competitiveness of existing industries in order to increase their export potential or their potential to undertake import substitution.

The SSA report is divided into six sections:
Section one presents the Introduction, background, and objectives of the assessment, and Section two discovers the Manufacturing sector profile in Rwanda, Section three displays the drivers of change and their skills implication, Section four also presents the skills status in Rwandan Manufacturing Sector with skills supply for the Manufacturing sector and future implication in Section five. While the sector skills projection and forecasting to 2030 presented in section six. Finally, the last section presents the Conclusion and Key Recommendations for competitive needs of the sector to 2030, in the context of Rwanda's overall transformative vision.
The report is critical for Rwanda's private sector to continue to attract high-level skills that will drive growth in the sector and build a skilled and dynamic workforce to ensure current employers and interested investors access the skills they need, now and in the future. The report recommends that the provision of continuous learning and development is strongly related to business survival and competiveness of manufacturing industry. The evidence presented in this report suggests that if manufacturers invest in skills, they will obtain significant gains from doing so.

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SECTION 1: INTRODUCTION AND OBJECTIVES

The Private Sector Federation (PSF) is a professional organization dedicated to promoting and representing the business community in Rwanda. It is an umbrella organization made up of ten professional chambers that was established in December 1999 to replace the former Rwanda Chamber of Commerce and Industry. PSF's core mission is to represent and serve the interests of the entire private sector through advocacy while at the same time providing timely and relevant business development services that lead to sustainable private sector-led economic growth and development.

Rwanda's private sector has been a cornerstone in transforming and contributing to economic resilience and leading to inclusive growth, thus providing a broad employment base for the population and enhancing the GDP's growth. However, despite the informed national documents enshrining Rwanda's private sector as a led economy, reality shows that the current private sector still needs appropriate advanced skills to make them more competitive in the region and international markets.

In this context, the PSF commissioned a Sector Specific Skills needs assessment for Rwanda's Private to be more competitive than it is today, to eradicate skills gaps and penetrate both regional and international markets, thus reducing the current trade deficit in the Manufacturing industry in Rwanda.

1.1 Background and Context

Over the last two decades, Rwanda has had consistent economic growth. The Gross Domestic Product (GDP) per capita climbed from 225 USD in 2000 to 904.70 USD in2019. Between 2000 and 2011, GDP expanded at an annual rate of 8% on average[3]. Rwanda's economic growth reached 9.4 % of real GDP in 2019, owing to good performance in industry, which rose by 17.5 % (mainly due to a vibrant manufacturing sector and a burgeoning construction sector). The services sector grew 10.7 %[4]. Significant public investments in implementing the National Strategy of Transformation (NST1) have helped accelerate recent growth. The NST1 followed two five-year Economic Development and Poverty Reduction Strategies (EDPRS-1, 2008-2012) and (EDPRS-2, 2013-2018), under which Rwanda experienced robust economic and social performances. This acceleration was also aided by non-government sector investment, especially private investment. As a result, credit to the private sector has improved, particularly in the manufacturing sector, contributing roughly 17% of the country's GDP in 2019[5].

[3] https://tradingeconomics.com/rwanda/gdp-growth-annual
[4] World Bank Group, Rwanda Economic Update: Accelerating Digital Transformation in Rwanda, January 2020
5 http://rdb.rw/export/export/products-directory/manufacturing-sector/

Despite the government of Rwanda (GoR)'s efforts to assist enterprises that have been severely affected by the epidemic, COVID 2019 represents a significant threat to Rwanda's long-term growth trajectory, which requires for average annual growth rates of more than 12% over the next few years (between 2025 and 2035).

Vision 2050 aims to achieve upper-middle-income status by 2035 (with a GDP per capita of USD 4,035) and high-income status by 2050 (with a GDP per capita of USD 12,476) by sustaining high rates of inclusive economic growth[6]. Although the current public investment drive will continue for the remainder of NST1, maintaining a 10% growth rate over NST1 without significant private sector investment will become increasingly difficult. Therefore, achieving the growth rates necessary to reach Upper-Middle-Income levels requires a vibrant, competitive, and innovation-driven private sector that can take over as the economy's main growth engine.

Compared with countries (notably in East Asia) that achieved an income trajectory even approaching Rwanda's aspires to achieve by 2035, Rwanda would require significantly higher savings and private investment rates and productivity growth[7]. The aspirational high-growth would also require highly developed human capital, increased export, technological innovation, and other productivity improvements. In terms of export as a share of GDP, Rwanda will need double-digit year-on-year export growth for every year up to 2035. Meeting such a target, Rwanda will have to produce high-quality products for the region and develop other similarly tradable and productive sectors. Like other fast-growing countries, Rwanda will focus on export-led manufacturing to boost productivity while providing a significant opportunity for low-skill workers to transfer from subsistence agriculture to higher-productivity modern sectors quickly[8].

The importance of the manufacturing sector's development has been emphasised in policy initiatives (such as Vision 2020, EDPRS, NST1, and Private Sector Development Strategy/PSDS), emphasising the need for a strong focus on light manufacturing a catalyst for economic growth and job creation. In a similar vein, the NST1 calls for the expansion of manufacturing as an export driver for the period 2017-2024 in order to equip Rwandan enterprises for global market entry and to generate growth and structural transformation. Skills play a critical role in accomplishing the manufacturing excellence agenda shared by nearly all companies in the industry.

The manufacturing industry is widely perceived as critical in achieving long-term economic growth and generating higher incomes. Manufacturing allows for economic diversification and has the potential to add significant value. Developing the manufacturing sector has many benefits, in particular, "the strong potential for increasing value-added, potentially important technological spill over effects, access to foreign know-how, stimuli to greater innovation, and a general knock-on effect on other sectors of the economy through created demand for goods and services."[9]Moreover, producing high-quality products for the region for broader markets could do for Rwanda what manufacturing did for East Asia from the 1990s[10].

Building skills to advance the country's economic agenda is a priority in the GoR's ongoing NST1. Presently, the government has identified economic sectors, which are critical for its economic development and have the potential for growth, exports, or job creation in the Made in Rwanda (MIR) policy document. This policy is geared towards upgrading the quality, market-relevant skills in the manufacturing industry. Therefore, the Private Sector Federation (PSF) commissioned this Sector Skills

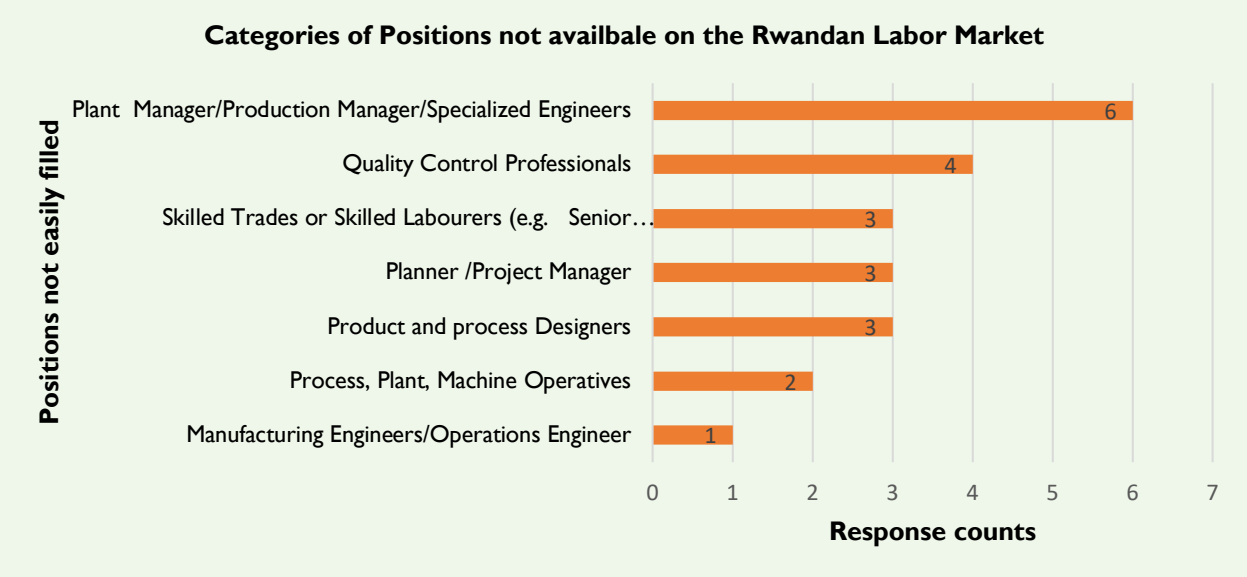
[6] Ministry of Finance and Economic Planning (MINECOFIN): Key Statistics on Rwanda (October 2018)
[7] World Bank and Government of Rwanda (2019). Future drivers of growth in Rwanda
[8] World Bank and Government of Rwanda (2019). Future drivers of growth in Rwanda
[9] Government of Rwanda, Ministry of Trade and Industry, Rwanda Industrial Capacity & Performance (Vienna: UNIDO, 2009),
[10] World Bank and Government of Rwanda (2019). Future drivers of growth in Rwanda

Assessment (SSA) to highlight the quality and market-relevant skills to build a competitive sector that can support the country's long-term economic transformation. Therefore, the emphasis of this SSA Report is on the human capital implications of the competitive needs of the sector to 2030, in the context of Rwanda's overall transformative vision.

A significant proportion of the sector's skills needs have already been examined by the Rwanda Development Board (RDB) through various skills audit reports (in 2012 and 2017). These Skills Audits focused on taking stock of available skills and projecting required skills indicated severe skills deficits[11]. Other Documents such as that on National Skills Development and Employment Promotion Strategy (NSDEPS), MIR Policy are also relevant in this regard. All of this literature revealed that the manufacturing industry is experiencing a skills shortage in crucial manufacturing jobs.

This implies that some firms were compelled to hire skilled staff from abroad, which significantly increased production costs, limited competitiveness, and restricted potential manufacturing exports. Many of the recommendations in these reports and studies are being implemented in line with Rwanda's efforts to build a competitive and innovation-driven private sector with a new set of skills aligned with sectors and labour market demand. The following Figure (1.1) shows the categories of positions not available on the Rwandan Labour Market.

Figure 1.1: Categories of Positions not available in the Rwandan Labour Market



Source: Customized from Primary Data Collection, 2020

1.2 Rationale

The manufacturing industry is still facing significant challenges such as insufficient infrastructure, a shortage of skilled labour force, limited stagnating market demand, and inefficient resource allocation. In addition, this sector is plagued by a lack of technological innovation and an inability to capture the majority of the downstream value contributed to its resource-based products.

The study focuses on a critical concern for policymakers in recent years, skill mismatch in Rwanda, mainly in the sector. Various strategic economic development documents and reports point out the

[11] RDB, Skills Audit manufacturing sector, 2017.

need for qualified labour to support economic growth in Rwanda throughout different sectors. The NST1 emphasizes that matching the skills acquired in education to those required by the labour market facilitate employment generation and foster economic growth. This is confirmed by recent economic reports and projections, which identified the mismatch of education (both graduate and vocational) and the labour market as the critical growth constraints that reduce employment and innovation.

1.3 Objective and Scope of the Assignment

The overarching objective of the study is to critically assess the skills requirements of the Manufacturing sector in Rwanda over the period 2020-2030 and formulate policy recommendations to ensure that the future skills requirements of the sector can be addressed out to the end of NST1 to deliver within the transformed business environment successfully. More specifically, the study aims to:

i. Provides information on the current performance of the Manufacturing, its workforce and the demand and supply, shortage, gaps and required of skills in sector expected performance.
ii. Assessing the global drivers of change impacting the Manufacturing and the relevant consequences for future skills needs;
iii. Identifies areas to be prioritized for action in the short, medium and long term
iv. Forecasting the skills for the Manufacturing Sector up to 2030 based on mid and long-term national development and specific targets to deliver on.

1.4 Methodology

1.4.1 Methodological Approach

To conduct the Manufacturing Sector skills needs assessment, the study employed different methods and approaches. A desk review was undertaken of relevant literature and documentation on the manufacturing sector in Rwanda and in various countries, including a review of documentation on skills assessments previously conducted, and capacity development approaches. The review also covered manufacturing statistics, reports, academic literature, articles on skills assessment and capacity building as well as reports issued by international bodies and professional firms. In addition, qualitative information was also collected via interviews with senior managers, heads of department in a representative sample of real estate and construction companies (see Annex 1).

A quantitative data collection from stakeholder institutions was carried out through online survey, comprising questionnaire covering companies' profiles, skills specifications, qualifications and experience. Thus, the data were then processed and analysed to form the basis of the current report, which highlights findings and ways for developing the skills in the sector of the Manufacturing. The SSA report builds on an extensive existing literature, complementing it with online survey and on-site consultations and an updated statistical analysis of the National Institute of Statistics of Rwanda (NISR) and relevant stakeholders' insights in the Manufacturing Sector.

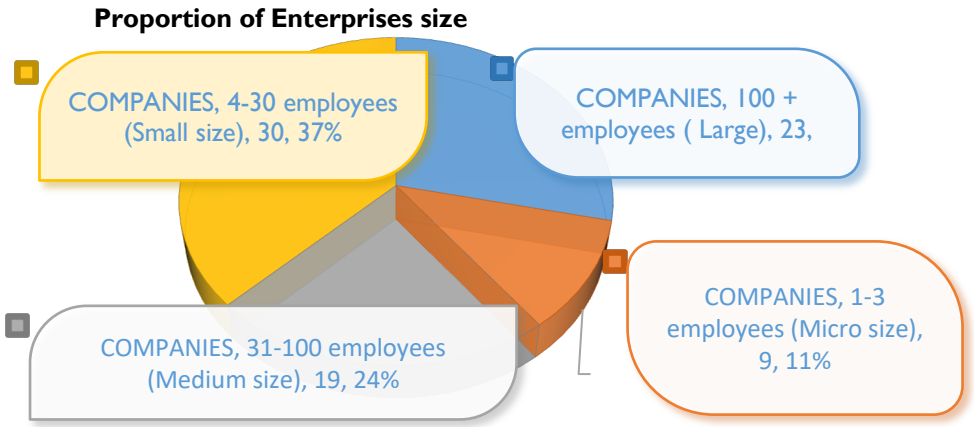
1.4.2 Assessment Process

The assessment was conducted through the process that was guided by systematic conduction of steps that led to obtaining data that shaded light to the real situation in terms of skill in the manufacturing sector. The Assessment was conducted in four stages as illustrated in the graph below:

There was a short scoping stage, during which research tools were developed, and the manufacturing subsectors were identified. The selection of subsectors was based on a literature review and analysis of the May 2020 Index of Industrial Production[12].

As illustrated in Figure (1.2), small and micro manufacturing enterprises account for 37 % and 11 % of all enterprises, respectively, with 52 % of these enterprises employing four or more workers.

Figure 1.2: Distribution of Manufacturing Enterprises participating in the Assessment



Source: Customized from Primary Data Collection, 2020

[12] NISR: April 2020 Index of Industrial Production, June 2020

1.4.3. Participative Approach

In assessing the required skills in the Manufacturing sector in Rwanda, PSF and its stakeholders were informed by a participatory approach. Therefore, it involved participation and consultations by senior management, staff, other relevant stakeholders, and some key PSF senior personnel. The survey covered the identified categories or a representative sample of the Manufacturing sector and its subsectors including all actors in the sector. In addition, the interviews participatory approach also covered the regulatory and supervisory bodies as well as institutions involved in manufacturing sector capacity (see a full list of interviewees is provided in Annex).

1.4.4. Key Informant Interview

Furthermore, this assessment used face to face or calls phone interviews with Key Informants using an interview guide. With this method, Key informants were identified in close collaboration with the client (PSF) from relevant stakeholders and/or members about its functioning and mandate. Anticipatively, the stakeholders were contacted (listed in annex) for a conversation aimed at helping the consultant team to gather relevant information about the subject under study. In developing this assessment report, different views were collected from different establishments. Participants in the interviews were purposively selected.

1.4.5 Response Rate

It was initially planned to conduct consultations with **90** companies from eight identified subsectors to participate in the online survey, while 12 firms were purposively visited and interviews held to complement and enrich responses from the survey. As shown from *graph* below, 68 out of 90 expected companies were covered, making a responsive rate of **75.5%,** largely sufficient and representative to make significant analysis.

1.4.6. Data analysis

The survey data was processed and analyzed to form the basis of the current report, which highlights the key findings and recommendations for developing skills in manufacturing sector.
The computed data allowed consultants to produce charts and graphs indicating skills gap, required and availability. Analyzed data informed the looking at critical skills that can transform and boost the sector to become competitive in the region and beyond. Some of the critical skills in demand and in which firms have vacancies that they are having difficulty filling. These include (i) specific technology-related skills, which include mechanical technical skills, science, technology, engineering and math (STEM) skills and ICT-related digital skills, and (ii) soft skills, (iii) analytical skills including critical thinking, data analytics, and research.

In parallel to the employer interviews and online survey, secondary data sources and literature were also analyzed. Key data sources also includes the RDB Skills Survey, the Labour Force Survey, National skills development and employment promotion strategy, Manufacturing Sector Country Report, Rwanda Economic Update/REU, PSDS, MIR Policy.
The data analysis revealed the manufacturing sector is heavily influenced by developments relating to advanced manufacturing technologies, such as:

(i) the growing 'computerization' of production processes, as well as the prevalence of Computer-Aided Design (CAD) and bespoke software solutions;

(ii) an increase in the resources required to test and inspect new products, as more complex materials and smaller components are used in production processes;
(iii) a shift to shorter production runs and more customized products is driven by customer demand and facilitated by new manufacturing techniques such as 3D printing and plastic electronics.

1.5 Report Outline

The SSA report is divided into six sections:

Section one presents the Introduction, background, and objectives of the assessment, and Section two discovers the Manufacturing sector profile in Rwanda, Section three displays the drivers of change and their skills implication, Section four also presents the skills status in Rwandan Manufacturing Sector with skills supply for the Manufacturing sector and future implication in Section five. While the sector skills projection and forecasting to 2030 presented in section six.

Finally, the last section presents the Conclusion and Key Recommendations of the Assessment Report.

SECTION 2: MANUFACTURING SECTOR PROFILE IN RWANDA

Across the World, the manufacturing sector has played an important role in driving economic development by stimulating and sustaining high productive growth, boosting employment opportunities for semi-skilled labour and building country competitiveness through exports. Very few countries in the world have managed to industrialize and develop without the manufacturing sector playing a leading role. Rwanda's manufacturing sector is one of the main drivers of economic growth, poverty alleviation, and job creation through task-based production. According to the Rwanda SMEs Development Policy (2010) and ISIC (Rev.4), Manufacturing enterprises in Rwanda have been categorized as micro, SME, and large enterprises, and the size of the enterprise has been grouped based on the number of employees.

2.1 Introduction

This section provides a statistical profile of the manufacturing sector and sub-sectoral data available, drawing from various sources, including the Business and Investment Climate Survey (2019), Rwanda Enterprises Census (2017), Rwanda Economic Update reports, etc. The objective is to assemble a picture of trends in manufacturing in Rwanda with a particular emphasis on changing employment and skills needs.
The Government of Rwanda aspires to be an upper-middle-income country with USD 4,035 GDP per capita by 2035. To attain its target growth rate, the government is already implementing several initiatives to diversify and increase exports and value addition and quality improvement among manufacturing firms[13].

2.2 Manufacturing industry in Rwanda

The manufacturing sector is a fundamental driver of the economy in Rwanda. According to a report of the Ministry of Finance and Economic Planning (MINECOFIN, 2013-14), the manufacturing sector was growing at high rate due to the facilities that were made available. The government has embraced an expansionary fiscal policy to reduce poverty by encouraging manufacturing and services sectors.
In 2019, the manufacturing industry contributed about 17 % to the country's GDP[14] . According to World Bank Rwanda Economic Update (REU), strong growth in manufacturing reflects heavier demand in the subsectors that feed into construction and the overall progress in the "*Made in Rwanda*" initiative. Growth in manufacturing was robust in wood, paper, and printing, where output expanded by 50 %. In comparison, non-metallic mineral products grew 38.5 %, chemicals, rubber & plastic products grew 25 %, and metal products, machinery, and equipment expanded 17.2 %[15].

The manufacturing sector in Rwanda is still small but steadily growing at an annual rate of 7%[16]. Before COVID 19 pandemic, Rwanda targeted increasing the industrial sector's value-added contribution to GDP to 24% and 33 % by 2035 and 2050, respectively. Several policies and strategies such as the Made in Rwanda policy, Special Economic Zone (SEZ) policy, the Domestic Market Recapturing Strategy (DMRS), SMEs strategy, the National Export Strategy, and Cross Border trade strategy have been developed to accelerate industrial and export growth. The country has also put in place a National

[13] Newfarmer, R. & Twum, A. (2018). Promoting Industrialization in Rwanda. *International Growth Centre Report*. Rwanda.
[14] http://rdb.rw/export/export/products-directory/manufacturing-sector/
[15] World Bank Group, Rwanda Economic Update,2020
[16] https://rdb.rw/invest/

Industrial Policy that aims to diversify the economy by increasing industry share to the country's GDP and increasing off-farm jobs. In addition, Rwanda's strategic location has boosted cross-border trade and increased trade volumes with her neighbour's, especially East-Central Africa, with an estimated population of 268 million. Essential manufacturer products exported include; beverages, dairy products, processed food, and construction materials.

To increase the local domestic and foreign supply of manufactured goods, the government has put in place the SEZ and 9 Industrial parks across the country[17] where all manufacturing industries are located. The SEZ seeks to attract investments in all sectors, but specifically in manufacturing and related services such as information and communication, trade and logistics and mining and construction.

Rwanda has access to African and global markets through robust free trade agreements, namely[18]:

Figure 2.2: African and Global Markets through Robust Free Trade Agreements

Source: Rwanda Development Board, 2021

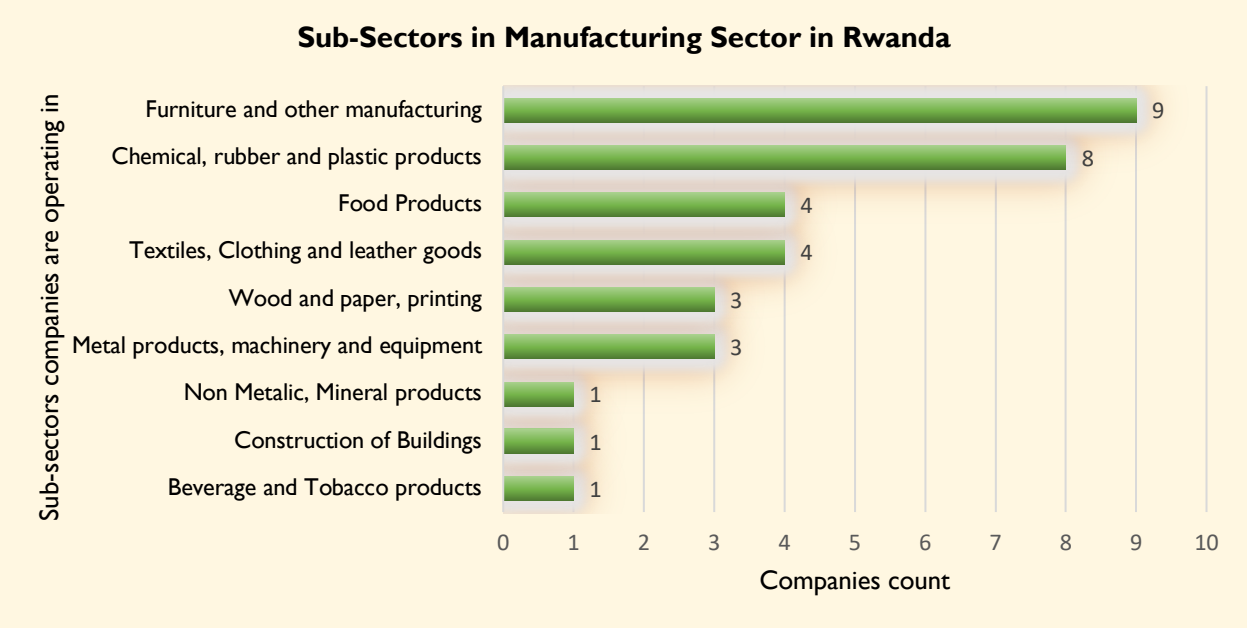
Through the WTO's special and differential treatment provisions, Rwanda has privileged access to several foreign markets. This has included access to US markets due to the United States' unilateral commitment to lower tariffs under the African Growth and Opportunity Act (AGOA).

2.2.1 Subsector in Manufacturing Industry

The manufacturing businesses transform a range of materials into new products. These products include food products, leather products, clothes, furniture, pharmaceuticals, paper, textiles, etc.
The scope of the Manufacturing Sector in Rwanda is specified in terms of 8 categories of the National Institute of Statistics of Rwanda (NISR: IIP 2020). Accordingly, Rwanda's manufacturing sector comprises the following eight (8) subsectors/economic activities:

[17] Industrial Parks in Bugesera, Rwamagana, Muhanga, Nyagatare, Musanze, Huye, Nyabihu, Rusizi, and Kicukiro
[18] https://rdb.rw/investment-opportunities/manufacturing/

Figure 2.1.1: Subsectors in Rwanda Manufacturing Industry



Source: NISR, 2020

2.2.2 Size and Characteristics of Rwanda manufacturing sector

Whereas the manufacturing output grew over the past decade, the industry is still small in Rwanda compared to most other African countries. In total, there are 14 195 manufacturing enterprises in Rwanda[19]. The manufacturing sector is characterised by gradual diversification[20] from basic manufacturing to more value-adding activities in other sub-sectors that include:

1. Fast-moving consumer goods such as detergents, body care products, paper tissues, plastic goods, papers, chemicals, beverages, textiles, leather and footwear, and cosmetics;
2. Construction materials such as granite tiles, cement, roofing sheets, and tiles and steel bars and light items;
3. Furniture Laboratory Equipment and;
4. Electronic & Automotive manufactured goods such as phones, computers, and vehicle assembly.

The economy is heavily dependent on the growing manufacturing sector as primarily and entirely manufactured exports from Rwanda have found a large market in the EAC region due to their high quality and strategic positioning. Although Rwanda's liberalized economy has exposed locally manufactured products to stiff competition from imports, compliance with required international standards gives them an upper hand[21].

2.3 The contribution of the Manufacturing industry to GDP

Manufacturing plays a critical role as a driver of exports, as an employer, source of revenue, and as well as a key driver of Rwanda's economic growth:

[19] National Institute of Statistics of Rwanda (NISR), Establishment Census, 2017, Rwanda
[20] http://rdb.rw/export/export/products-directory/manufacturing-sector/
[21] http://rdb.rw/export/export/products-directory/manufacturing-sector/

- Over the past decade, Rwanda's manufacturing sector has experienced fast growth. In 2019, the manufacturing industry contributed about 17% to the country's GDP. Strong growth in manufacturing reflects heavier demand in the subsectors that feed into construction and the overall progress in the "Made in Rwanda" initiative (REU: Jan. 2020). Growth was robust in wood, paper, and printing, where output expanded by 50 %, while non-metallic mineral products grew 38.5 %, chemicals, rubber & plastic products grew 25 %, and metal products, machinery, and equipment expanded 17.2 %;

- In the first quarter of 2020, manufacturing activities grew by 6% due to 11% in food processing, 11% in textiles, clothing & leather, and 5% in the production of chemicals and plastic products boosted by the increase in soaps other cleaning products. However, wood & paper printing and non-metallic mineral products declined by 11% and 6%, respectively[22];

- In June 2020, the Index of Industrial Production (IIP) shows that manufacturing output decreased by 8.3 % compared to June 2019. The decrease in manufacturing is due mainly to a decrease of 16.9 % in manufacturing of beverages and tobacco, 49.4 % decrease of manufacturing of textiles, clothing, and leather goods, 16.9 % decrease of manufacturing of non-metallic mineral products, and 9.4 % decrease of manufacturing of chemicals, rubber and plastic products. However, the decrease in manufacturing is tempered by the increase in food manufacturing (22.2 %) [23].

Rwanda's entirely produced exports have found a large market in the East African Community (EAC) region due to their high quality and strategic positioning[24]. However, the sector's share of the economy and exports is still small. Furthermore, the manufacturing sector has been overshadowed by domestic economic development, which is predominantly driven by consumption and construction over the last decade. Overall, exports remain small since most manufacturers produce for the domestic market.

2.4 Broad Employment Trends

As Rwanda aspires to achieve a knowledge-based society, human capital investment is crucial for employment and poverty reduction and productivity and growth of firms[25]. To date, however, local manufacturing enterprises cite shortfalls in technical and soft skills as a severe impediment to their productivity and expansion. The government has responded to the shortfall by investing heavily in technical education and skills training, even if primary education has received less attention. This challenge is evident when comparing literacy rates to EAC countries.

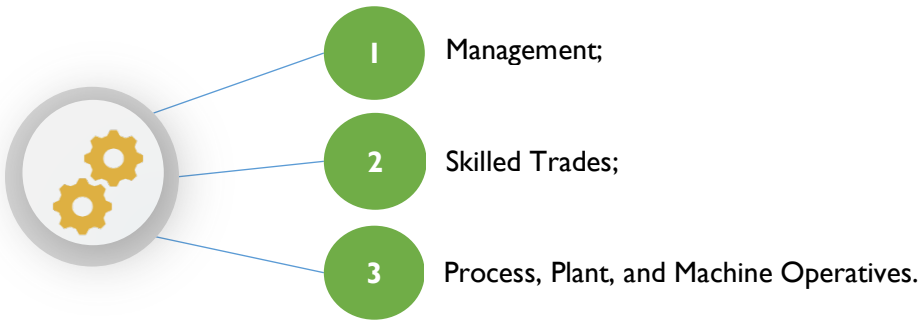
The Rwanda Labour Force Survey[26] (RLFS) shows that approximately 208,956 people are employed in manufacturing in 2019, accounting for 6.4 % of total formal employment. The branch of economic activity with the next highest number of employed persons was traded (14.8 %), followed by construction (9.6 %), manufacturing (6.4 %), activities of households as employers of domestic personnel (6.3 %), and Transportation and storage with 5.2 %. The other branches of economic activity comprised less than 5 % of total employment.

[22] NISR: Gross Domestic Product First quarter 2020
[23] NISR, June 2020 Index of Industrial Production (IIP)
[24] http://rdb.rw/export/export/products-directory/manufacturing-sector/
[25] International Growth Centre: Rwanda Strategy Note, 2017
[26] NISR, Rwanda Labour Force Survey (2019), Annual Report, March 2020

The Labour Force Survey trends February 2020(Q1) shows that the number of employed persons increased from about 3,186,000 in February 2019(Q1) to about 3,569,000 in February 2020(Q1). However, the share of employment in manufacturing and construction generally decreased as compared to the previous quarter. On the other hand, the share of employment in agriculture generally increased in the same period. Broadly, employment in the market-oriented agriculture sector increased by about 4.1 % from February 2019 to February 2020. In addition, employment in the industry sector decreased by 2.5 %, while employment in the service sector also declined by 1.6 % in the same period. Four manufacturing sub-sectors accounted for about 65 % of the manufacturing growth in 2019 (REU)[27].

2.5 Occupational profile in Rwanda Manufacturing Sector

The Manufacturing workforce consists of people working in Managerial, Skilled Trades or Production Operative occupations, with significant numbers working in Professional occupations, and a smaller number of Associate Professional occupations. Comparatively large proportions of employees characterise the Manufacturing workforce in three main broad occupational groups:



The occupational composition of those employed in manufacturing varies considerably by sub-sector. For example, comparatively high percentages of the workforce reside in the higher level occupations in the Manufacture of Pharmaceutical, Chemical, and Electronic Products and Beverages, as well as Scientific R&D; and higher percentages of the workforce are found in the lower level occupations in the production of Food Products, Wearing apparel, Paper Products, Textiles and Rubber & Plastics. This assessment focuses on key occupations prevalent in manufacturing industries, representing a cross-section of skills levels. The following table shows the distribution of manufacturing occupations with the most significant number:

Table 2.5.: *Main Occupational Manufacturing professionals (the most significant numbers)*

Occupations	Description	Related Jobs
Production, Works, and Maintenance Managers	Production works and maintenance managers plan, organise, direct and co-ordinate the activities and resources necessary for production in manufacturing industries and the maintenance of engineering items, equipment, and machinery.	♦ Engineering Manager ♦ Factory manager ♦ Production manager ♦ Service manager ♦ Shift manager ♦ Works manager ♦ Engineering Manager ♦ Industrial Engineer ♦ Manufacturing Engineer Manager ♦ Mechanical Engineering Manager

[27] REU: 2020

Occupations	Description	Related Jobs
		♦ Production Engineering Manager
Metal Working Production and Maintenance Fitters	Metalworking production and maintenance fitters erect, install and repair electrical and mechanical plant and industrial machinery, fit and assemble parts and sub-assemblies in the manufacture of metal products and test and adjust new motor vehicles and engines.	♦ Aircraft engineer ♦ Aircraft fitter ♦ Aircraft ground engineer ♦ Bench fitter ♦ Engineering fitter ♦ Fitter and turner ♦ Machine fitter ♦ Maintenance fitter ♦ Mechanic-fitter ♦ Millwright ♦ Plant fitter
Food, Drink and Tobacco Process Operatives	Food, drink, and tobacco process operatives set, operate, and attend machinery to bake, freeze, heat, crush, mix, blend, and otherwise process foodstuffs, beverages, and tobacco leaves.	♦ Bakery assistant ♦ Brewery worker ♦ Dairy worker ♦ Process worker (food products)
Metal Working Machine Operatives	Metalworking machine operatives operate machines to cut, shape, rub and otherwise machine metal, use hand and power tools to remove surplus metal and rough surfaces from castings, forgings, or other metal parts, and clean, smooth, and polish metal work pieces.	♦ Fettler (metal trades) ♦ Grinding machinist (metal trades) ♦ Metal polisher ♦ Press operator (metal trades) ♦ Shot blaster ♦ Tool room machinist
Electricians, Electrical Fitters	Electricians and electrical fitters assemble electrical and electronic equipment, install, maintain, and repair electrical plant, machinery, appliances, and wiring.	♦ Electrical engineer ♦ Electrical contractor ♦ Electrical fitter ♦ Electrician ♦ Maintenance electrician
Welding Trades	Welding trades workers join metal parts by welding, brazing, and soldering, and cut and remove defects from metal using various equipment and techniques.	♦ Arc welder ♦ Electric welder ♦ Fitter-welder ♦ Spot welder ♦ Welder
Metal Machining Setters and Setter Operators	This unit group operates machines to drill, bore, grind, cut, and mill or otherwise shape metal work pieces.	♦ Centre lathe turner ♦ Machine setter (metal trades) ♦ Machine tool setter ♦ Setter (metal trades) ♦ Setter-operator (metal trades) ♦ Tool setter-operator
Marketing and Sales Managers	Production planning and expediting; materials management; transportation to and from the plant; shipping, receiving, and traffic management.	♦ Distribution Manager/Director ♦ Supply Chain Manager/Director ♦ Import/Export Manager ♦ Production Planning Manager ♦ Supplier Quality Manager

Occupations	Description	Related Jobs
		♦ Transportation Manager ♦ Warehouse Manager ♦ Business sales executives ♦ Crater/Packer ♦ Packaging Machine Operator ♦ Shipping/Receiving Clerk

Source: Customized from Primary Data Collection, 2020

There are significant numbers employed in specialised positions within different occupational groups:

(1) In managerial occupations, there is a strong presence of functional and production managers;
(2) Engineering and ICT professionals that work to improve production process;
(3) Laboratory technicians and other science/engineering production technicians feature strongly within associate professionals;
(4) There are a variety of craft occupations prominent within skilled trades, including metal forming, welding, fitting, instrument making, electrical and electronic trades, construction, printing, and food trades;
(5) Food and drink process operatives, chemical process operatives, plant and machine operatives, and assembly/general operatives feature strongly within the operatives group.

The above various types of occupational manufacturing professionals are essential indicators of skills demand in the sector. The qualifications profile within the manufacturing sector is highly diverse depending on the subsector. Consequently, there are no pre-set entry standards. Entry is possible with either a degree or equivalent qualification, relevant experience, or without academic qualifications. On-the-job training is provided, and professional qualifications are available.

SECTION 3: DRIVERS OF CHANGE AND THEIR SKILLS IMPLICATION

The primary drivers of change in Rwanda's manufacturing sector are examined in this section, which includes:

- Examples of how drivers of change impacts on the manufacturing industry and the relevant consequences for future skills needs;
- The principles of influence of each of the selected drivers on Manufacturing and the implications for skills;
- Summaries of the drivers identified by the different Sector Skills Councils for their own branches of Manufacturing, and their relative importance; and
- The resulting prioritisation of drivers for Manufacturing.

3.1 Introduction

Manufacturing's skill demand results from numerous factors that have shaped and will continue to shape the industry. To meaningfully assess how demand and supply of skills will respond to changes in the world over the coming years, the most helpful approach was to consider a set of significant change drivers and assess the kinds of change that each would be expected to influence concerning skills. The principal global drivers of change are:

Figure 3.1: Global drivers of changing skills needs of the manufacturing sector

Source: UNCTAD (2011) World Investment Report, 2011

The implications of these drivers from a skills perspective are considered throughout.

3.2. Policy and regulation

Rwanda is a rapidly growing developing country, with average GDP growth of over 7% per annum since 2010, backed by a strong policy framework. The country's GDP growth rate during the period 2010–2018 has been one of the most dynamic among African countries. Vision 2020 laid the groundwork for Rwanda's progress towards a middle-income export-oriented economy, through prioritising knowledge-based industries. Whilst steps have been made, to achieve this long-term goal Rwanda must build a skilled and dynamic workforce, meeting the demand for an additional ~5M quality jobs by 2050.

Despite these commendable achievements, the country still faces challenges that may threaten its transition to a higher income level. As highlighted in the policy documents (Industrial Policy, MIR, NST1, Vision 2050), manufacturing industry is an engine of sustained growth; it has the capacity to create backward and forward linkages, serves as an impulse for innovation and has the capacity to generate economies of scale.

The development of the manufacturing sector and the related necessary skills and capability are the key prerequisite for the country to capture the opportunities provided by the new wave of technological revolution. Adequate skills for Industry 4.0 and investment promotion for economic diversification" is identified as an important intervention to boost industrialization and sustained growth in the medium- to long term.

Vision 2050 foresees Rwanda as an upper middle income country by 2050. To realize this audacious ambition, it emphasizes innovation, integration, agglomeration, and competition as key drivers for sustained, inclusive growth in Rwanda, with a focus on six priority areas: (1) human capital development; (2) export dynamism and regional integration; (3) well-managed urbanization; (4) competitive domestic enterprises; (5) agricultural modernization; and (6) capable and accountable public institutions. Skills and jobs weave a common thread through all of these priority areas of Vision 2050.

With the points above-mentioned, there are policy and regulatory instruments that have significant implications for manufacturing activity and hence for the sector's demand for skill. These may include; MIR policy, Industrial Policy, Global Value Chain Strategy, Business Environment and Investment Climate, SMEs strategy, National Export Strategy, National Export Strategy, Technology and Innovation, and Digital economy.

The implementation of these policies and compliance with related standards need to be accompanied by the adequate skills. These skills can be grouped into three categories, namely (i) specific technology-related skills, which include mechanical technical skills, science, technology, engineering and math (STEM) skills and ICT-related digital skills, and (ii) soft skills, (iii) analytical skills including critical thinking, data analytics, and research.

3.3. Technological innovation

The principal challenge facing the manufacturing sector is the rapid pace of technological development taking place globally and impacting the overall operating environment for the sector, with both internal and external challenges. The challenge most commonly reported by manufacturing firms interviewed and industry stakeholders consulted was external competitors in the regional markets. The second leading internal challenges were competitive firms-with a robust ecosystem for technological innovation, world-class human capital, and robust institutions of governance that can compete in and penetrate the global markets and environment.

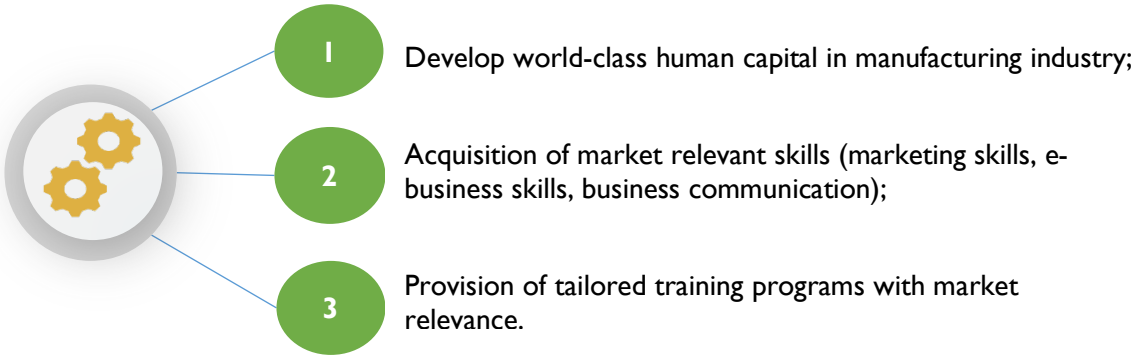
Rwanda is in the early stages of building its innovation capacity, which is the ability to introduce new products, processes, ideas, technologies, and solutions. It needs to continue strengthening firm capabilities for productivity-led growth to meet its long-term income ambitions. Although structural transformation and improved resource allocation can stimulate labour productivity growth for another decade or so, sustaining it over a more extended period will only be possible through innovation and technology diffusion. As manufacturing firms are becoming innovative, Rwanda's manufacturing firms need to understand the potential of new technologies, materials and how they can develop new products and new, improved and sustainable manufacturing processes (i.e., computer-aided manufacturing technology in the textile industry). They need workers with science, technology, engineering, and mathematics (STEM) skills who can respond to shifts in technology.

Developing the capacity to innovate is not an overnight endeavour; it requires blending digital skills and uniquely human skills. As digital transformation and the Fourth Industrial Revolution redefine manufacturing jobs, leaders and workers alike need to embrace a new work environment. Here, advanced technology and digital skills must blend with uniquely human skills to yield the highest level of productivity and innovation. Understanding how work might change will help the manufacturing industry as a whole prepare for a future that promises to be transformative.

3.4 Competition and Emerging Market

Rwanda's manufacturing sector sees itself being exposed heavily to international competition, with both cost and non-cost factors being crucial to its ability to compete. The ability of Rwandan firms to compete globally depends on the "competitiveness" and "connectedness" of their neighbours. Rwanda is, therefore, likely to seize regional trade opportunities through intraregional trade and participation in regional value chains connected to the global market[28]. Trade expansion also implies the need to attract Foreign Direct Investment (FDI) because multinational companies bring in managerial, technical, and designed skills while their networks facilitate access to new export markets[29]. Rwanda will need highly skilled people who can adapt to change, think innovatively, and identify the new products and processes that will help firms corner new markets. This will require exploring opportunities for acquiring quality, market-relevant skills, providing quality training, and expanding opportunities for continuous upgrading skills for sustained employability.

3.4.1 Priority Actions Highlighted by Employers

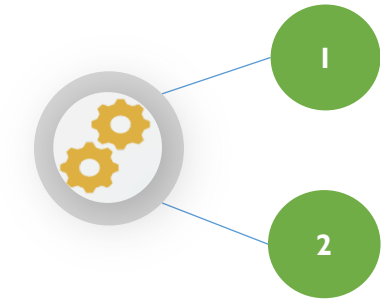


[28] World Bank and Government of Rwanda (2019). Future drivers of growth in Rwanda
[29] Freund, C., and T. Moran. 2017. "Multinational Investors as Export Superstars: How Emerging Market Governments Can Reshape Comparative Advantage." Working Paper 17-1, Peterson Institute for International Economics, Washington, DC.

3.5 Research and Development (R&D)

Manufacturing is a crucial driver of R&D activity. The competitive manufacturing environment puts a particular emphasis on research activities, not only in the context of R&D for new products but also the ability to absorb technologies and expertise developed externally, which can drive innovation in manufacturing products and processes. In light of increasing worldwide competition, Rwanda's manufacturing performance will depend on its ability to introduce new products into its business.
There is increasing demand for high-quality science and engineering graduates to enter and progress in the sector to meet this need. In particular, in advanced manufacturing industries, the connection between universities and business goes much further than the supply of new entrants. For example, there is an almost umbilical relationship between R&D, university-based innovation, and industry spin-offs of products developed in higher education in the life sciences.

3.6.1 Priority actions highlighted by Employers:



1. Support industrial R&D, which is stimulating demand for highly skilled graduates and increasing collaboration between research centres and manufacturing industry;
2. Investing more in development of science, technology, engineering and mathematics- with a focus on specialized skills supply in STEM.

3.6 Export-Oriented Growth

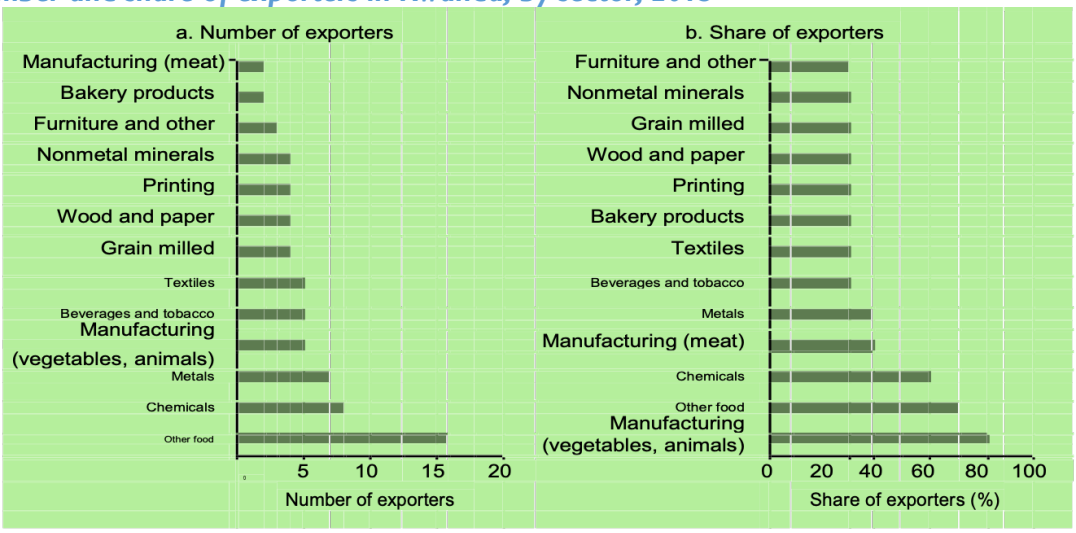
Most countries that recently achieved high growth did so through export-oriented manufacturing. In East Asian countries, export-oriented manufacturing played a critical role in boosting productivity growth[30]. It did so in part by being export-oriented, which enormously helped increase the within-sector productivity of manufacturing firms. Competing in the international arena meant that firms had to accelerate their learning process to remain competitive: firms that did not adjust went under, freeing up labour and resources for other companies. More significant interaction with other international actors also helped absorb foreign technology, while larger market size allowed firms to exploit economies of scale, further improving labour productivity[31].

In light of the above, Rwanda cannot achieve its growth aspirations without a significant export push. Stimulating exports requires considerable investment in addressing Rwanda's skills deficit. Some employers (particularly SMEs) are experiencing difficulties in identifying and taking advantage of export opportunities due to a lack of market research skills, contacts, or networks in regional markets and a lack of knowledge in different legal and regulatory frameworks.

Rwanda's currently small domestic market makes it necessary for exports to be a driver of growth. However, there is still quite some room for improvement because the country had only 69 manufacturing exporters in 2015 (Figure 3.3)[32]. Therefore, increasing integration in regional and global markets is vital for achieving growth from a policy perspective.

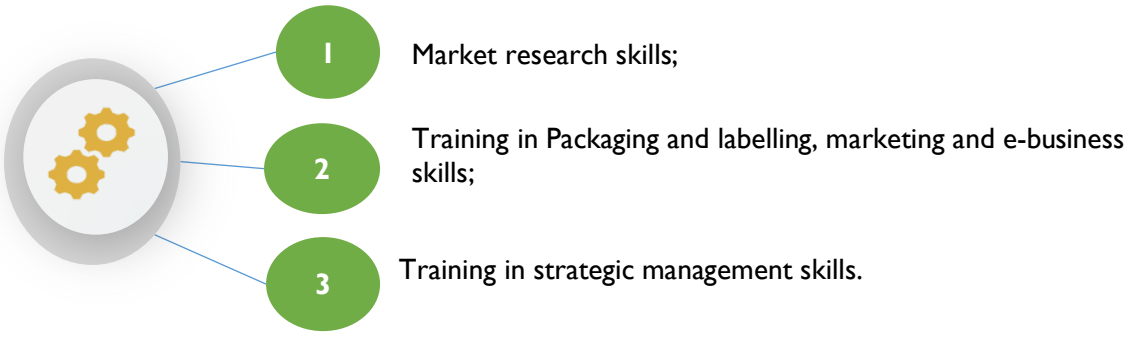
[30] Newman et al. 2016
[31] Herrendorf, Rogerson, and Valentinyi 2013.
[32] World Bank Group and Government of Rwanda (2019). Future drivers of growth in Rwanda

Figure 3.6. Number and share of exporters in Rwanda, by sector, 2015



Source: Future Drivers of Growth in Rwanda - Calculations based on NISR -2017.

3.6.1 Priority actions highlighted by Employers:



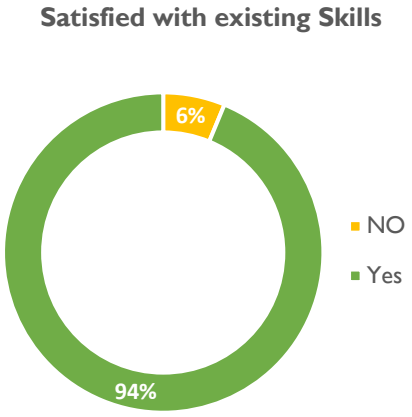
3.6 Implications for Skills

The factor which tends to ensure that one manufacturing firm remains more competitive than another is that of possessing the skills which allow new products to be developed (e.g., innovation skills), then brought to market. Several manufacturing firms consulted drew attention to the high business and employment impact that a critical person with industry-leading skills can have at the firm level. They are valuable from a jobs policy perspective because they can drive activity that boosts employment. They may drive improvements in business performance far out of proportion to the cost of hiring them through driving product development, commercialisation, operational performance or marketing, and through improving decision-making. However, the sector is generally small-scale, informal, and has a

small foothold in external markets, despite the impressive set of business-friendly reforms that Rwanda has implemented.
Skills and costs competitiveness and the business environment are, therefore, primary driver of competitiveness in manufacturing. The quality of skills available to the manufacturing sector depends on the development of the existing workforce and the relevance of the graduates from the education and training sector. The Science, Technology, Engineering, and Maths (STEM) pipeline from the education system to the labour market is significant to the manufacturing sector.

The future development of the sector will be influenced strongly by its competitiveness in international markets. Alongside cost competitiveness, skills will be one of the key factors driving future competitiveness and future employment levels. Skills have a central role in pursuing the manufacturing excellence agenda common to almost all sectors.

Figure 3.6: Satisfied with existing skills in the Manufacturing sector



As highlighted above, one of the main implications of shifting to more technology-intensive and higher value-added manufacturing activities is an increasing demand for higher skills across all manufacturing roles. Therefore, to build a competitive Rwandan Private Sector that can tap effectively into domestic, regional, and international market opportunities, this SSA Report recommends focusing on skills at all levels, from operative to researcher skills. In addition, there is a focus on skilled trades, technicians, and engineers across the sector

CHAPTER 4: SKILLS STATUS IN RWANDA MANUFACTURING SECTOR

This section reports the findings of the skills assessment conducted. It provides the skills available, required and skills gaps and shortages in Manufacturing Sector. The section also describes the assessment carried out on skills requirements in the sector. The research approach comprises the following elements:

(1) Online Survey and Structured interviews conducted at the senior company representative level with over 90 selected companies from different subsectors. They included small and large companies;
(2) Consultations held with 12 different manufacturing stakeholders, including representative bodies, education institutions and professional bodies.

4.1Introduction

Working in manufacturing industry in Rwanda could be considered in broad terms to cover two main types of activity: (i) that associated with the technicalities of the design, development and production process for the sub-sector's products; and (b) those associated with what is needed to run any production enterprise. Rwanda aspires to be an upper-middle-income country with USD 4,035 GDP per capita by 2035. To attain its target growth rate, the government is already implementing numerous initiatives to diversify and increase exports and value addition and quality improvement among manufacturing firms. To unlock her full potential, harnessing her regional and global markets will be important in overcoming the skills gap.

4.2 Current Skills in manufacturing sector

The quality of skills to the manufacturing sector depends both on the development of the existing workforce and the relevance of the graduates from the education and training sector. The Science, Technology, Engineering and Maths (STEM) pipeline from the education system to the labour market is particularly important to the manufacturing sector.

4.2.1 Skills availability by occupations levels

In this skill assessment, the online assessment tool has been used to map out the skills required to work in the Manufacturing Sector across the value chain and in the four occupational levels (manager/specialist, professional, technician and artisan).

The assessment has identified 'talent driven innovation' (which encompasses quality availability of the labour force/quality and availability of scientists, researchers and engineers/ capacity for innovation) as the most important global driver of change for the manufacturing industry ahead of costs of labour and raw materials.

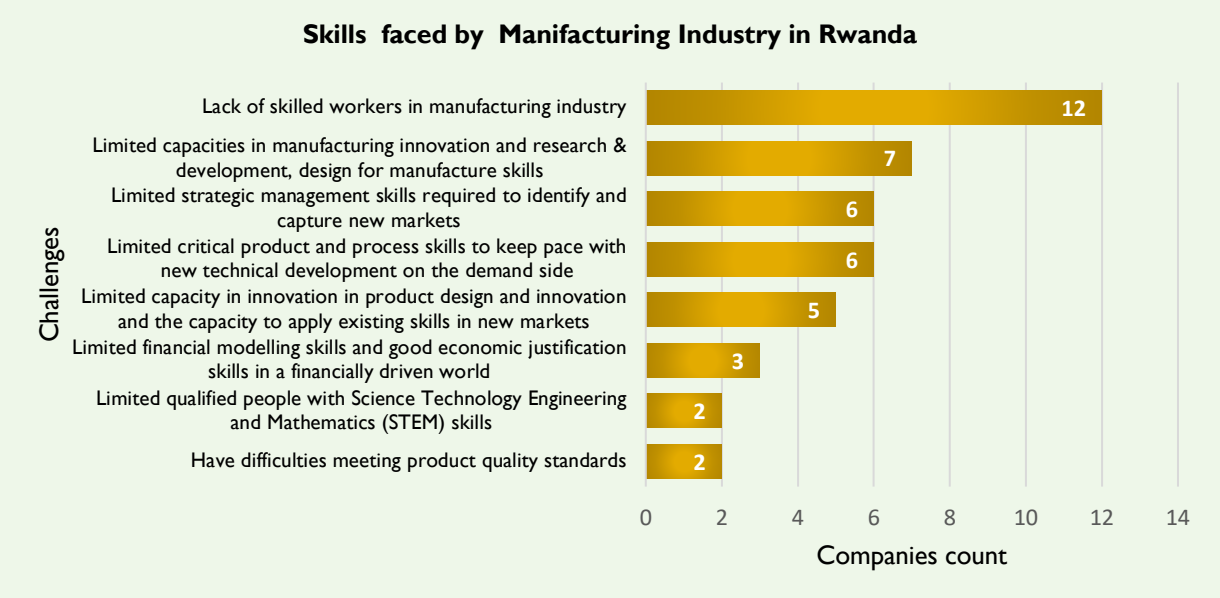
Rwanda has significantly promoted STEM education across all levels of study which contributed to increase the number and quality of graduates with knowledge, skills, abilities and other characteristics needed by all occupations within manufacturing industry (e.g. STEM graduates). According to 7 Years Thematic Statistical Report[33] (2013-2020), almost 23,254 people have been being provided on courses in areas relevant to the manufacturing sector: Pharma-chemicals; Food and Beverage; Green Economy; ICT and; Medical Devices. A further expansion of the STEM initiative has been announced in 2020 with the official launch of STEM power Centre to boost science awareness in Rwanda. Therefore, an increased outflow of STEM graduates to the labour market has been observed in the recent years due to various Centres of Excellence established during the period of seven years (2013-2020). Total graduate in STEM stand at just over 16,000 in 2020. Both science and engineering programmes experienced similar rates of increased graduate. There have been strong increase number of graduates, particularly in ICT related programmes, electrical engineering and mechanical engineering.

Within knowledge-based manufacturing, value creation from human capital is now more likely to involve a higher level of autonomy, and rely on the judgment, insight and know-how of individuals, who draw upon their specialist knowledge. In this context, the development of both technical and soft skills is equally important. This is observable across all manufacturing occupation types, and in all types of business activity. Whether in the operation of machinery and equipment, or in the provision of business services, value creation is maximized as individual workers manage complexity, not simplicity. Furthermore, globalization together with advances in ICT, and the associated increase in intra-industry trade, has increased specialization of production. As firms become more specialized, the requirement is for a higher level of technical skill in the workforce and management.

4.2.2 Skills gaps

As indicated in Figure 4.2.2.a manufacturing enterprises reported skills problems. These do not necessarily imply a headcount shortage but can indicate a scarcity of relevant skills externally that they expect to affect them if they hire a skills gap.

Figure 4.2.2.a: Skills gaps faced by Rwanda Manufacturing Industry



Source: Customized from Primary Data Collection, 2020

[33] University of Rwanda, 7 Years Thematic Statistical Report, 2020

The assessment found out there is large technical skills gap amongst most sector employees (56% only having either primary or secondary level of education without any manufacturing techniques). Limited skills mix partly explains low levels of the country's manufacturing. Professional engineering and scientist occupations were the most frequently mentioned in both skills shortages and deficiencies in skills. Skilled trades and Technicians were the most frequent skills shortage mentioned, closely followed by branding and marketing occupations. The skills shortages mentioned most frequently are mechanical engineers, electronic engineers, software, materials specialists, and chemistry graduates. SMEs interviewed reported having more limited strategic management skills, which results, sometimes, in a less than ideal alignment between business opportunity, business style, and workforce skill structures.

Firms surveyed were asked about the occupational areas where pursuing opportunities, or strategic objectives are most likely to impact employment numbers or skills requirements. All of the main occupational categories were mentioned. Still, most mentions were for manufacturing engineering or research and development occupations, as may be seen in the above figure 4.1. This suggests that, if firms succeed in pursuing these opportunities and objectives, the share of employment accounted for by engineering and science occupations will rise.

The following Table 4.2.2 disaggregates the manufacturing engineering and occupational management groups by skill area. They are distributed across a significant number of areas, with the production process, product design, automation, mechanical and electronic engineering appearing most frequently, but with several other manufacturing operations and management disciplines featuring significantly.

Table 4.2.2: *Skills Gaps by professional occupational in Manufacturing Industry*

Occupational areas	Skills gaps
Manufacturing Engineering	♦ Companies reported having limited skills in the production process (design, development, implementation, operation, maintenance, and control of all processes). Skills gaps identified by companies were primarily technical, ranging from operative to professional engineering level. ♦ Deficiency in skills included design and manufacturing engineers (engineers with materials expertise for new product design and testing in metals area) to improve component design for manufacture and deliver flexible automation solutions (lack of automation skills). There is a need for skills in computerised technologies that aid in the design and creation of products. This also works for additive manufacturing; ♦ A shortage of polymer technicians and engineers hinders product innovation in terms of mould design for product development, prototype runs, troubleshooting, and validating new processes; ♦ Textiles and pharma-chemical firms have also identified a lack of chemistry skills: Chemistry skills required include analytical chemistry and organic chemistry. Advanced, in-process, analytical techniques are required for continuous processing; ♦ Firms indicated gaps in the supply of skills for computer numerical control (CNC) machining for precision engineering work in machining moulds and engineering tolerance; ♦ Another issue for manufacturing companies has been the initial training of operators to work in an engineering environment; ♦ SMEs report experiencing skills gaps in the business aspects of the production manager role

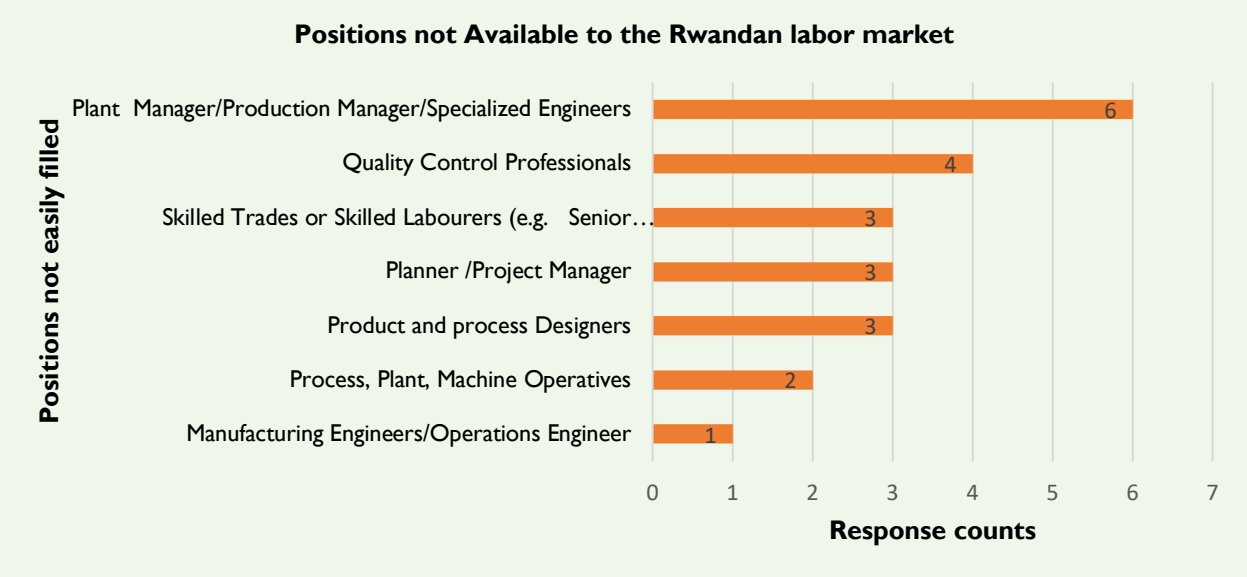
Occupational areas	Skills gaps
Research, Development, and Innovation	♦ Staff in production have limited capacities in research and product innovation ♦ Limited qualified people with Science Technology Engineering and Mathematics (STEM) skills ♦ Lack of Computer-Aided Design (CAD) skills ♦ Numbers of firms identified shortages of automation, mechanical and electronic engineers
Supply Chain Management & Logistics	♦ There is a deficiency in technical salespeople who can go out to customers, understand their technical and business needs, and build a relationship. Associated with this, there is a need for staff with English languages for technical selling and other customer-facing commercial roles; ♦ Current skills gaps identified in interviews tended to be commercial and related to people skills compared to other sectors where technical skills were needed; ♦ Firms identified some future technical skills needs in the context of future opportunities and strategies; ♦ Lack of business acumen-business-related skills; ♦ They raised a need for technical procurement skills, for example, engineers with commercial knowledge who can work with suppliers on technical matters and have the skills to negotiate the terms of a supply agreement.
Strategic Management	♦ Some managers lack supervisory/management skills required to supervise and direct the technical personnel responsible for every stage of production to ensure the manufacture of high quality and cost-effective product; ♦ Planning and organising skills; ♦ Companies mentioned a deficiency in supervisory skills, production planning, and material requirements planning (MRP) to differentiate their product by adding new product features and securing new businesses and increasing volumes.
Quality Management	♦ Some companies indicated having difficulties meeting product quality standards due to a lack of regulatory compliance skills

Source: Customized by the Consultant

In addition to the technical skills, soft skills are also inadequate or lacking for a majority of employees. Most establishments reported communication skills, critical thinking, problem solving and leadership as inadequate and hampering their operations.

Due these skills gaps some firms reported they were compelled to hire skilled staff from abroad, which significantly increased production costs, limited competitiveness, and restricted potential manufacturing exports. Many of the recommendations in these reports and studies are being implemented in line with Rwanda's efforts to build a competitive and innovation-driven private sector with a new set of skills aligned with sectors and labour market demand. The following Figure (4.2.2.b) shows the categories of positions not available on the Rwandan Labor Market.

Figure 4.2.2.b: Positions Not Available On the Rwandan Labor Market



Source: Customized from Primary Data Collection, 2020

4.3 Causes of Skills gaps

The skills gap exists due to several underlying causes which have been examined in this assessment. The KIIs revealed that there are not enough skilled workers in manufacturing industry. Referred to as the manufacturing skills gap, this issue revolves around the labor market being unable to find workers who have the manual, operational, and highly technical skills, knowledge, or expertise to take the some open positions. The manufacturing skills gap is the reality that many manufacturers are facing right now.

In addition, the consultations and interviews with KIIs revealed that the major cause of the skills gap is the adoption of newer technologies. Yet with more automated processes and robotics used on the plant floor, these technologies are actually creating more jobs within operations. Manufacturing Companies need workers who understand robotics, the Internet of Things (IoT), artificial intelligence, and analytics. As a result, manufacturers are expanding and diversifying their workforce with open positions for; (a) Robot teaming coordinators, (b) Smart factory managers, (c) Digital twin engineers, (d) Smart Quality Assurance (QA) managers. However the assessment revealed there is no singular issue contributing to the problem. As highlighted by manufacturers, the factors that can impact the skills gap include; a) Lack of Technology Skills Sets, b) Industry 4.0 Skills requirement due to rapid pace of digitalization adoption in the manufacturing industry; lack of Manufacturing experience/Know-How, Lack of physical experience with manufacturing tools, such as welding and machining.

The skills gap exists due to several underlying causes, which will be examined in this subsection. Capacity gaps are concentrated within the skilled trades occupations. The majority of the identified reasons for companies failing to develop their employees' capacity or potential are reported in Figure 4.3. below:

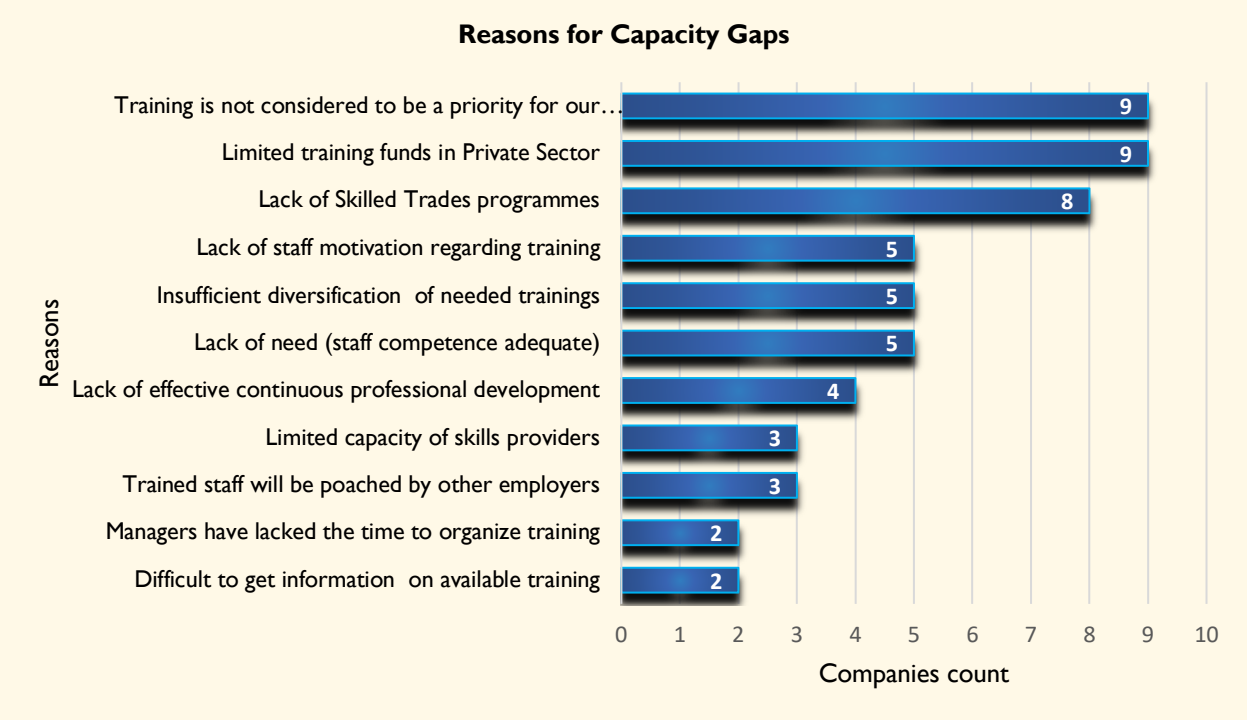


Figure 4.3: Reasons for Capacity Gaps

4.4 Required Skills in Manufacturing Industry

When firms were asked about their most essential occupations in 2030, most mentions were engineering and science occupations, with technicians, branding, and marketing occupations also featuring significantly.
According to manufacturing firms consulted, Engineers should have core skills associated with one or more of the leading engineering disciplines, with mechanical, electrical, electronic, and chemical/process engineering being the main disciplines relevant to manufacturing.

The assessment found that the most needed skills are (in no order): i) Digital Fluency, ii) Ability to Writing and Understand Code, iii) Ability to Program Manufacturing Specific Machines and Devices, iv) Experience in Machining, Fabricating, and Complex Assembly, v) Big Data Analytics, vi) Robotics, vii) Soft Skills.

Figure 4.4. shows the number of mentions of each of the primary skills that need to be improved in order to increase productivity and quality product standards as well.

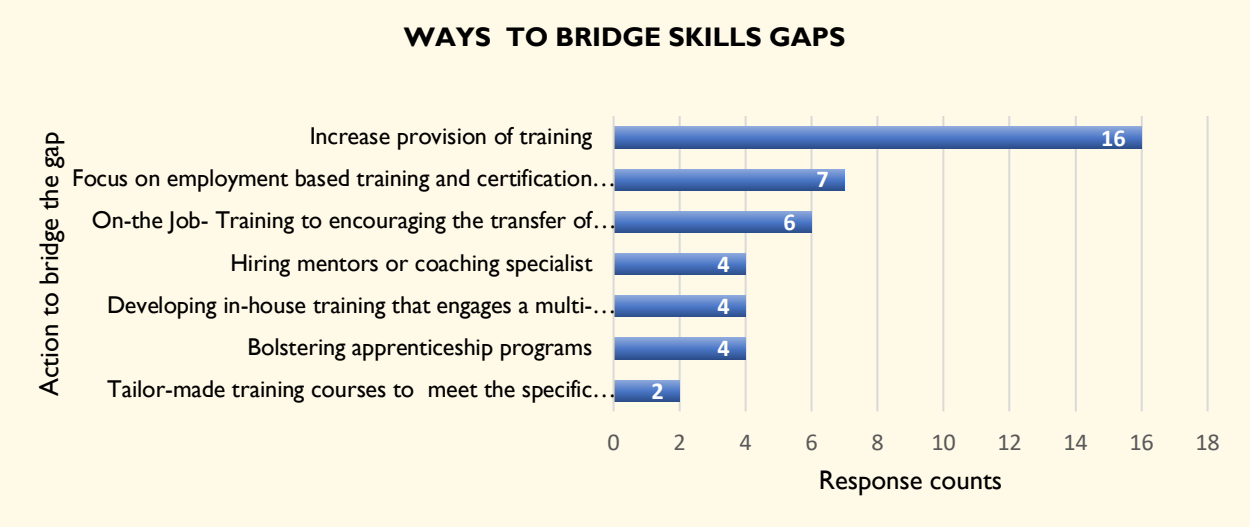
Figure 4.4: Top Skills desired to increase productivity in manufacturing industry in Rwanda

Source: Customized from Primary Data Collection, 2020

4.5 Ways to bridge the skills gaps

Enterprises use a variety of strategies to address skills gaps. The interview survey asked about what they do in three broad areas: Upskill and training existing employees and recruiting newly skilled in Rwanda, and recruiting abroad. Therefore, Figure 4.5 summarises the findings.

Figure 3: Ways to bridge skills gaps



Source: Customised from primary data collection, 2020

Table 4.5.a: *Ways to bridge skills gaps*

Approaches	What	Number
Upskill and Train existing employees	♦ Increase provision of training and investing in STEM ♦ Focus on employment-based training and certification courses; ♦ On-the-Job- Training to encouraging the transfer of knowledge; ♦ Bolstering apprenticeship program; ♦ In House Training ♦ Experienced people with the right skills ♦ Tailor-made training courses based on particular needs; ♦ Cooperation in the development of dedicated curriculum and VET delivery (between firms and educational institutions) and align VET programs to the labour market	16 7 6 4 4 4 2
	Sharing the skills needs to Training Service Providers	21
	Development of dedicated curriculum and VET delivery	7
	Collaboration between Private Sector & Training providers in setting qualification standards	5
	Close cooperation in course design and delivery through a "dual model" combining school-based learning with practice in a company	4
	Evolving models of employment-based training	3
Recruit qualified people	Experienced people with the right skills and additional certification	6
Recruit outside Rwanda	Skilled people and coaching/ mentor specialist from abroad	4

Source: Customized by the Consultant

Based on the evidence from interviews and stakeholder consultation, some ways prove successful in closing skills gaps through training and education provision. However, one of the difficulties in addressing skills gaps mentioned by manufacturing enterprises has been the weak alignment between manufacturing and higher education institutions. Many SMEs, in particular, say that they find it challenging to engage with third-level institutions, but Institutes of technology tend to engage more proactively than universities.

Several firms proposed that the relationship between education providers and industry should be much closer. The rate of technological change has accelerated, and any educational providers' "time lag" will be worsened in the future. While there are many examples of positive links between HEIs and the manufacturing industry, the quality of the relationship appears to vary by institution, and companies expressed their concern that this is not consistent or well structured.

The evidence from KIIs indicate that the ways to bridge the skills gaps are to:

- Investing more in development of science, technology, engineering and mathematics with a focus on specialized skills supply in STEM: With robust STEM education infrastructure, workers can easily perform experiments independently and improve their problem-solving skills as needed by the knowledge-based economy. RP/TVET and Universities are urged to update their programs to localize the STEM education and make it more practical to accommodate efficient methodologies of teaching science in schools and colleges. At the same time, Manufacturing firms need also to be encouraged to significantly invest in the country's STEM education. While the common thread permeating manufacturing sector hires is STEM, employers are looking for experienced people with right skills and with diverse educational backgrounds. Technical and vocational education and training (TVET), Higher education institutes universities are required to produce more and better-trained graduates for the coming years. The Government, through TVET Board, must continue to sponsor the programs that support short-and long-term professional training targeting manufacturing's key industries; and invest more industrial Research &Development which is stimulating demand for highly skilled graduates and increasing collaboration between research centres and manufacturing industries;
- Increase on On-the-Job- Training to encouraging the transfer of knowledge: the assessment found out that as firms seek workers to operate and maintain advanced machinery, a wide variety of skilled technician positions are opening for those without traditional university degrees. These jobs include professions such as industrial machinery mechanics and maintenance workers. Like many other technical positions, this job requires only a high-school diploma with most training done on-the-job or through apprenticeships.
- Provide tailored training programs with market relevance: increasing the human capital of manufacturing workers has two components - boosting technical and advanced conceptual skills. Even as Rwanda increases time in school, it has to continue to improve educational and upgrade the vocational and educational training systems. This require strong cooperation in the development of dedicated curriculum and VET delivery (between firms and educational institutions) and align VET programs to the labour market

SECTION 5: SKILLS SUPPLY FOR MANUFACTURING SECTOR AND FUTURE IMPLICATION

The previous section reported on the real and perceived skills gap in the manufacturing domain and provided some proposed ways to bridge the skills gaps for the future of manufacturing. This assessment aims to provide evidence relating to the skills position within Rwanda Manufacturing industry. This section:

- summarizes the key types of skills that are important to Manufacturing employers;
- examines the central importance to Manufacturing of Innovation and the Science, Technology, Engineering and Mathematics (STEM) skills needed for it; and
- investigates indicators which provide, through the best proxy available-qualifications and occupations-relevant quantitative evidence around skills supply and demand.

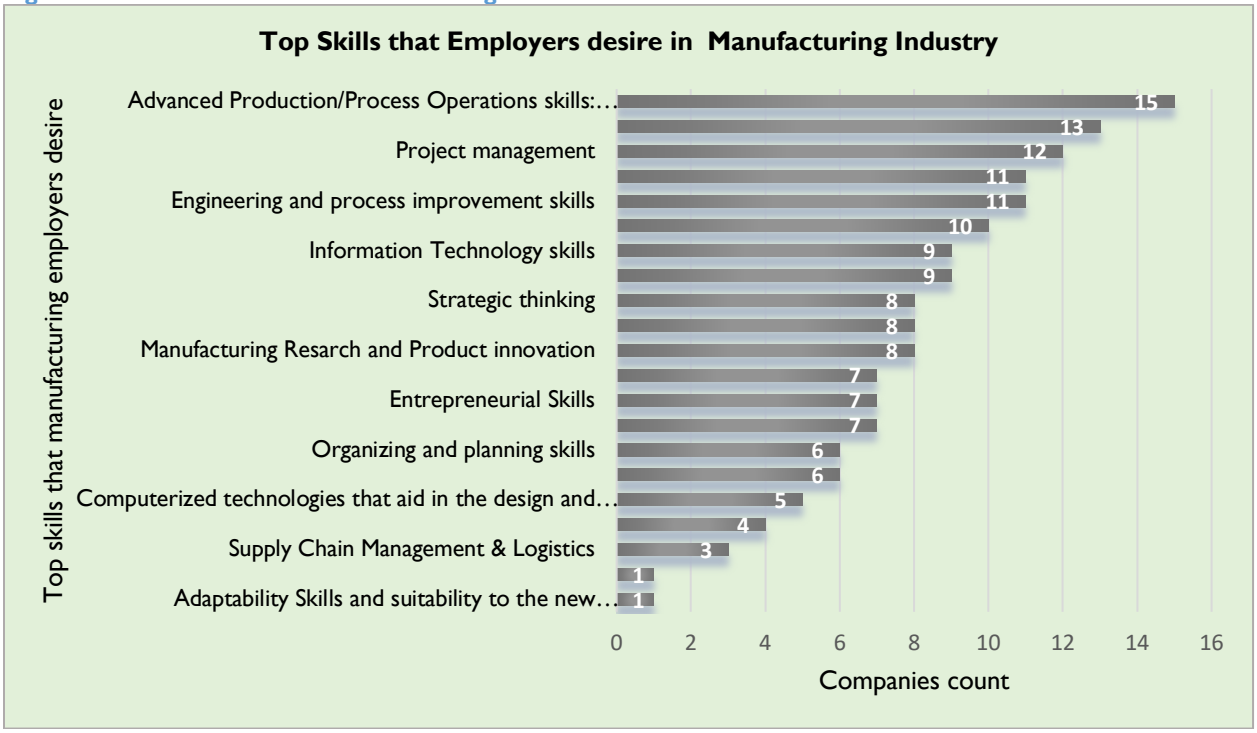
5.1Introduction

This section provides an assessment of potential skills supply to the manufacturing sector based on enrolments and graduates in STEM disciplines that are of direct relevance to the manufacturing sector. However, it is important to note that this is potential rather than actual supply and the career choices facing STEM graduates can vary widely. For example, graduates of biology or maths may pursue careers in the education/public research systems sector or business or financial services sectors. Many graduates will proceed to postgraduate learning and may diversify in disciplines different to their primary degree. Therefore, the information provided in this chapter should be interpreted as a potential pool of skills relevant to manufacturing rather than available supply. In this section, we look at the supply side issues facing the manufacturing industry, i.e., the technical skills available to the industry. The primary source of information is education and qualifications data. In future years these qualification patterns will alter, and qualification levels will generally rise. More formally qualified people will enter the workforce, and many of those that remain will improve their qualifications while some of the least qualified currently in work will leave. Both demand and supply-side factors will drive the changing qualifications structure.

Nevertheless, qualification patterns are likely to change much more than this because the training and educational systems are geared up to supply more qualified people into the labour market. In other words, there will be a ripple effect down the qualifications hierarchy. Such patterns will vary by industry. The construction of buildings, specialist contracting, professional services, and extractive and mineral processing sectors already experience problems recruiting the best people and show little evidence of participating in the rising demand for more highly qualified people. Consequently, there is a risk that these sectors will find it more difficult than others to attract graduates, and the relative qualifications levels in these industries will fall behind other parts of the economy.

Evidence gathered through a combination of research, online survey, consultations with industry stakeholders, and firm-level interviews identified the following top Skills that Employers desire to increase productivity (Figure 5.1.1) and meet manufacturing quality standards

Figure 5.1.1.: Skills desired in Manufacturing



Source: Customized from primary data collection, 2020

5.2 Technical skills for manufacturing engineers

Technical skills, or hard skills, are job-specific tasks that you need. Some hard skills for manufacturing engineering include; Higher mathematics, Computer science, Statistics, Advanced physics, and Nanotechnology. The technical knowledge is important and help worker to be a successful manufacturing engineer. Manufacturing firms consulted on their engineering and manufacturing management skills requirements emphasised the need for core engineering skills. As mentioned in the previous sections, engineers should have the core skills associated with one or more of the leading engineering disciplines, with mechanical, electrical, electronic, and chemical/process engineering being the main disciplines relevant to manufacturing. So long as an engineering course develops these core skills and is visible to prospective employers, biomedical or additive engineering variants may also be valued. Employers will not necessarily prefer a qualification tailored to their sector over a qualification in the most closely related primary engineering discipline.

According to the results of the consultations, the demand for validation engineering, quality engineering, automation engineering, supply chain engineering, and other professional level engineering specialisms that support manufacturing should be met primarily by qualified and experienced engineers who pursue further study in the area to develop the specialist skills required (Figure 5.1). Employment-based training and certification courses in manufacturing engineering, production engineering, manufacturing operations, technology and systems engineering, and total quality management (TQM) are the most appropriate responses to the skills gaps. Engineers with a strong knowledge of polymers are in demand in chemical, rubber, and plastic industries and parts of other sectors. Firms report a shortage of engineers with solid skills in that area.

5.3 Research and Innovation Skills

Companies consulted reported a need for researcher skills relevant to product development and innovation (Figure 5.1). This work requires high levels of skill and, at its more advanced levels, requires qualified people in research, development, and testing of products and processes; manufacturing, sciences, technology, systems engineering, or equivalent skill levels. Generating these skills requires higher education research. Existing moves to focus higher education research funding on industry-relevant topics and develop industrial postgraduate programs should significantly contribute to meeting these skills needs[34].

Many manufacturing firms consulted drew attention to the high business and employment impact that a key person with industry-leading skills can have at the organisational level. They may drive improvements in business performance far out of proportion to the cost of hiring them through driving product development, commercialisation, operational performance or marketing, and through improving decision-making. They are valuable from a job perspective because they can drive activity that boosts employment in the sector.

5.4 Soft Skills

Soft skills comprises of all qualities that are important when dealing with fellow co-workers and clients. These include problem-solving, communication skills, negotiations skills, critical thinking, team work, etc. Soft Skillshttps://www.thebalancecareers.com/what-are-soft-skills-2060852 are equally as important to technical detail and knowledge in manufacturing industry. Unfortunately, soft skills often are not taught in college or other educational institutions.

The necessity of having excellent soft skills in the manufacturing industry was stressed by firms and other stakeholders assessed through interviews and consultations. These are skills at all levels, particularly in terms of people skills, communication skills, problem-solving skills, planning skills, and project management skills that are appropriate to the level of work in the manufacturing sector. (Figure 5.1). The soft skills are essential enablers for manufacturing excellence. They are also important in other contexts, such as where contact with customers or suppliers is required, product development, when working with regulatory bodies, or when seeking to influence investment decisions by foreign companies.

5.5 Trades & Technicians Skills requirements

A significant number of manufacturing firms indicated general concerns about the supply of technical workers at skilled trades or technician level capable of working on machinery that combines mechanical, electrical, electronic, and IT/software technologies (Figure 5.1). The companies consulted also highlighted a shortage of people with toolmaking and machinist skills. The concerns in the industry about the supply of mechanical-electronic technicians and trades appear more diffuse. These skills are essential in the context of computer-automated technologies (CAT), e.g., computer-aided manufacturing, electrical discharge machining, and electronic design automation. They can be supplied through a combination of mechanical, electrical, electronic, and software/IT skills training and education, such as a certificate in mechatronic engineering or an apprenticeship-based certificate in electrical instrumentation, or through initial technical or trade certification training in a subset of these disciplines, followed by additional training in related areas afterwards.

[34] National Industrial Research and Development Agency, Annual Report, 2020, Rwanda

5.6 Provision of Manufacturing Related Education and Training

Although the manufacturing industry is popularly associated with manual labor, manufacturing now requires workers with advanced science, technology, engineering, and mathematics (STEM) skills. Since modern production relies heavily on automation, robotics, and cutting-edge materials, companies are desperate for professionals who can help them revolutionize their processes from research and development for new products to maximizing assembly efficiency. Manufacturing firms also need skilled technical workers to operate increasingly complex machinery, offering many opportunities for those without a traditional university education.

Rwanda has significantly promoted STEM education across all levels of study. For example, in 2019, Rwanda introduced the newly developed education curriculum referred to as the "New Competence-Based Curriculum" for pre-primary up to upper secondary education. This new curriculum underpins building a knowledge-based and technology-led economy through well-adjusted STEM and Information, and Communication Technology (ICT) led education[35]. Rwanda's Ministry of Education has partnered with technology-enabled companies such as Microsoft, O'Genius Panada, Zora Robotics and Class VR, and the Keza Company, among others, towards incorporating STEM and ICT-enabled educational system[36]. For example, this programme allows for the utilization of ICT and other technologies to promote transferable skills such as critical thinking, problem-solving, and creativity.

The Microsoft Technology teaching methodology utilizes robotics to improve students' hands-on engagement and activities.[37] These include students' exposure earlier on to computer programming and developing students computational and logical thinking to solve real-life problems. This is accomplished by modelling problems and designing solutions. Furthermore, Rwanda's One-Laptop-Per-Child (OLPC) flagship programme has encouraged ICT-enabled primary school education. Besides, the Rwanda Coding Academy flagship programme has prepared Rwandan youth into future software developers and cyber security systems experts.

In addition to developing a technology-enabled education curriculum, the Rwandan education system has been designed such that it allows for extended time allocation for STEM-related subjects relative to arts-related subjects. Further to this, Rwanda has significantly invested in essential STEM-related infrastructure such as laboratory equipment and accompanying material necessary for teaching STEM subjects. For example, in the past 25 years, Rwanda has equipped approximately 380 secondary schools with modern science laboratory tools[38]. Even though there is still more work to be done, Rwanda's STEM outputs are progressively improving[39].

Within higher education, there has been a significant increase in enrolments from 2011/12 to 2019/2020 in Science, Technology and Engineering disciplines relevant to the manufacturing sector. According to 7 Years Thematic Statistical Report[40], Total enrolment for the period 2013-2020 provides proportions of 45% students registered in Non-STEM and 55% students registered in STEM areas[41]. Students' enrolment for academic year 2019/2020 shows a total number of 25,084 with 36% Females and 64% Males respectively. Areas of registration show 64% registered in STEM versus 36% in Non-STEM

[35] https://www.mineduc.gov.rw/fileadmin/user_upload/Mineduc/Publications/POLICIES/Education_Policy
[36] https://allafrica.com/stories/202002140099.html
[37] https://news.microsoft.com/wp-content/uploads/prod/sites/43/2018/06/Transforming-Education-eBook
[38] https://www.cio.co.ke/stem-education-prioritised-in-rwandan-schools
[39] Kizito Ndihokubwayo, Investigating the status and barriers of science laboratory activities in Rwandan teacher training colleges towards improvisation practice, Rwandan Journal of Education - Volume 4 No 1 (2017)
[40] University of Rwanda, 7 Years Thematic Statistical Report, 2020
[41] University of Rwanda, 7 Years Thematic Statistical Report, 2020

Programmes. Therefore, an increased outflow of STEM graduates to the labour market can be expected in the coming years due to various Centres of Excellence established during the period of seven years (2013-2020). Total enrolments in STEM stand at just over 16,000 in 2020. Both science and engineering programmes experienced similar rates of increased enrolments. There have been strong increase enrolments, particularly in ICT related programmes, electrical engineering and mechanical engineering.

Enrolments at master level in University of Rwanda (UR) mainly relate to medicine and biological/biochem/chemical sciences; computing and electronics and engineering categories. Also, Carnegie Mellon University opened a campus in Kigali in 2012 and currently offers a Master of Science in Electrical and Computer Engineering and a Master of Science in Information Technology. There have also been strong increases in enrolments in environmental related programmes, reflecting the increasing influence of the environmental agenda.

In addition to the enrolment data outlined above, since 2013 provision relevant to the manufacturing sector has been expanded through the introduction of the STEM initiative, which strategically targets funding of STEM higher education courses in areas where there are identified labour market skills shortages or employment opportunities. Under seven years period (2013-2020) almost 23,254 people have been being provided on courses in areas relevant to the manufacturing sector: Pharma-chemicals; Food and Beverage; Green Economy; ICT and; Medical Devices. A further expansion of the STEM initiative has been announced in 2020 with the official launch of STEM power Centre to boost science awareness in Rwanda.

Rwanda's education policy emphasizes training teachers enhanced teaching pedagogy on lesson delivery that links classroom learning with the local environment. The curriculum framework incorporates teacher's capacity building that includes continuous professional development in school leadership, management, improvement planning, coaching, and mentoring. These capacity-building frameworks are put in place in Rwanda to address the barriers hindering the STEM uptake. In this way, Rwanda can address the limited number of qualified STEM teachers and STEM teachers' inability to localize STEM teaching. Such measures have somewhat improved the STEM education uptake in Rwanda.

With robust STEM education infrastructure, students can easily perform experiments independently and improve their problem-solving skills as needed by the knowledge-based economy. RP/TVET and Universities are urged to update their programs to localize the STEM education and make it more practical to accommodate efficient methodologies of teaching science in schools and colleges. Finally, Manufacturing firms need also to be encouraged to significantly invest in the country's STEM education.
While the common thread permeating manufacturing sector hires is STEM, employers are looking for experts across many fields and with diverse educational backgrounds. The assessment found out that as firms seek workers to operate and maintain advanced machinery, a wide variety of skilled technician positions are opening for those without traditional university degrees. These jobs include professions such as industrial machinery mechanics and maintenance workers. Like many other technical positions, this job requires only a high-school diploma with most training done on-the-job or through apprenticeships.
Technical and vocational education and training (TVET), Higher education institutes universities committed to produce more and better-trained graduates since 7 years. The Government, through TVET Board, sponsors programs to support short- and long-term professional training targeting Rwanda's key industries.
However, according to National Skills Development and Employment Promotion Strategy (RDB, NSDEPS: 2019), TVETs have not been fully effective in preparing students for the workforce: Employers rank programs poorly-only 60 percent of employers found TVET graduates with satisfactory skills. According to Africa Growth Initiative, the unemployment rate among TVET graduates amounted to 17

percent[42] in 2018; moreover, roughly half of TVET graduates reported that they were not satisfied with their skills development in the National Tracer Survey for TVET and Higher Education Graduates and Employer Satisfaction (MINEDUC: 2019). This situation can be attributed to two elements: insufficient private sector involvement in curriculum design and implementation, and nascent performance tracking especially for TVET institutions and labor market outcomes. Collecting and disseminating information on the quality of skills supply and the returns to different skills would improve quality and encourage participation in high-return programs.

The assessment found that a number of higher education institutes have specific expertise or centres dedicated to manufacturing, for example the Biomedical Engineering and E-health in University of Rwanda; the Food Science and Technology Research Centre in College of Science and Technology (CST); the Centre of excellence in Innovative Teaching and Learning mathematics and science in College of Education; Centre of Excellence in Internet of Things; and National Industrial Research and Development Agency offering an array of support services aimed at improving the competitiveness of existing industries in order to increase their export potential or their potential to undertake import substitution.

Overall, the numbers expected to graduate from higher education are increasing, however, as above mentioned the skills and competencies of these graduates to meet what will be required of the manufacturing sector is key. There are also a significant number of awards relevant to the manufacturing sector. Some of these awards are quite general (for example relating to IT skills), however, others are highly specific to manufacturing such as those relating to food processing, and materials manufacturing. The breadth and specificity of awards highlights that there are established standards for many of the competencies required at the lower qualifications levels of manufacturing, however, these may not be apparent or clearly mapped out to all learners and employers.

According to NEP Narrative Report[43] (RDB:19), there have been significant increase across most of the manufacturing apprenticeships and industrial attachment since 2015, coinciding with the period of Made in Rwanda Program. In particular, there has been a substantial relative increase in the numbers of fitters, electricians, metal fabricators, toolmakers and sheet metal workers. A small number of industry stakeholders as well as individual companies are involved in funding and/or provision of skills development within the garment manufacturing in Rwanda, such as Textile Enterprise, and National Industrial Research and Development Agency (NIRDA). In-employment education and training is essential within the manufacturing sector as new technologies, regulations, processes and products continually affect skills required by existing employees

In summary, increasing the human capital of manufacturing workers has two components- boosting technical and advanced conceptual skills. Even as Rwanda increases time in school, it has to continue to improve educational outcomes if the country is to achieve its high growth aspirations. It has to upgrade its vocational and educational training systems. The country may benefit from further reforms to its tertiary school system and universities.

[42] Richard Newfarmer and Anna Twum, Employment creation potential, labor skills requirements and skill gaps for young people. A Rwanda case study, February 2022

[43]RDB, NEP Narrative report covering the period from the financial year 2014/15- 2018/2019, Oct. 2019

SECTION 6: SECTOR SKILLS PROJECTION AND FORECASTING TO 2030

As previously discussed, there are many skills that are important to manufacturing sector that can be identified. Building a competitive manufacturing and future skills for key occupations are crucial to progress towards this assessment and meet the needs of the future labour market. In this section, we will take a closer look at the various skills that are projected to be essential and required to be successful in the future, smart, and digital manufacturing environment. It focuses on how these skills can be fostered and developed through sector skills response to address the skills gaps identified by projecting and forecasting to 2030.

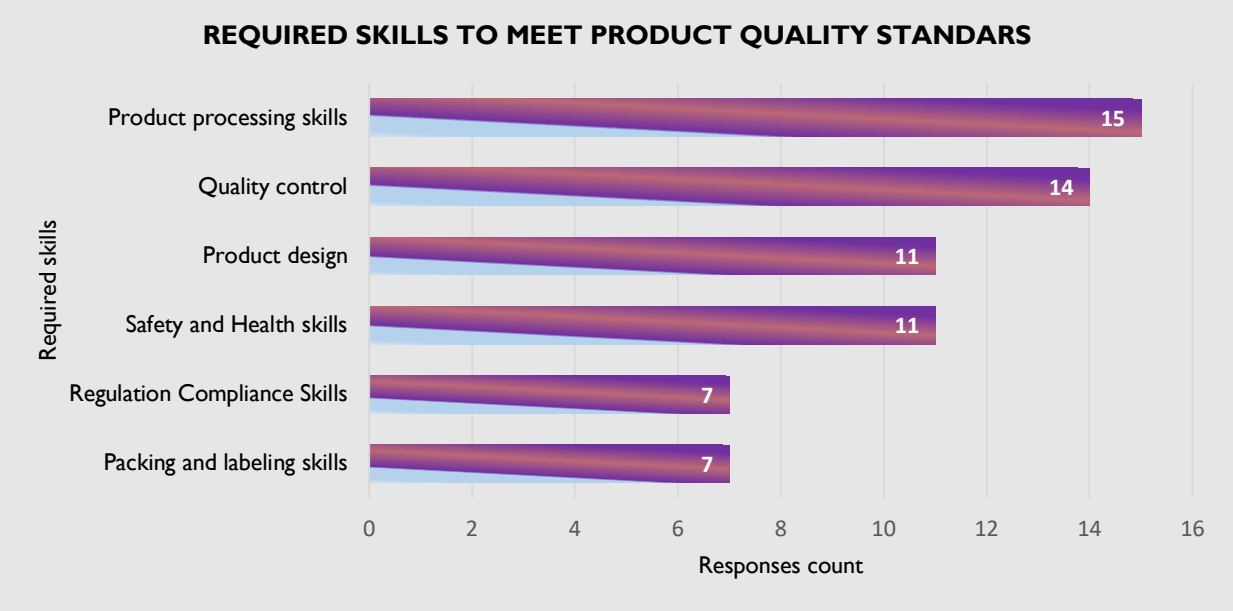
6.1 Introduction

The future skills demand in the manufacturing sector are based on drivers and trends as described in the section 3 of this report, and on informants' opinions in the sector, and based on historical trends in employment and occupations within manufacturing subsectors. They are based on different assumptions about drivers of manufacturing activity in Rwanda, focusing mainly on adequate skills for Industry 4.0 and investment promotion for economic diversification" to boost industrialization and sustained growth in the medium- to long term.

6.2 Building a competitive manufacturing

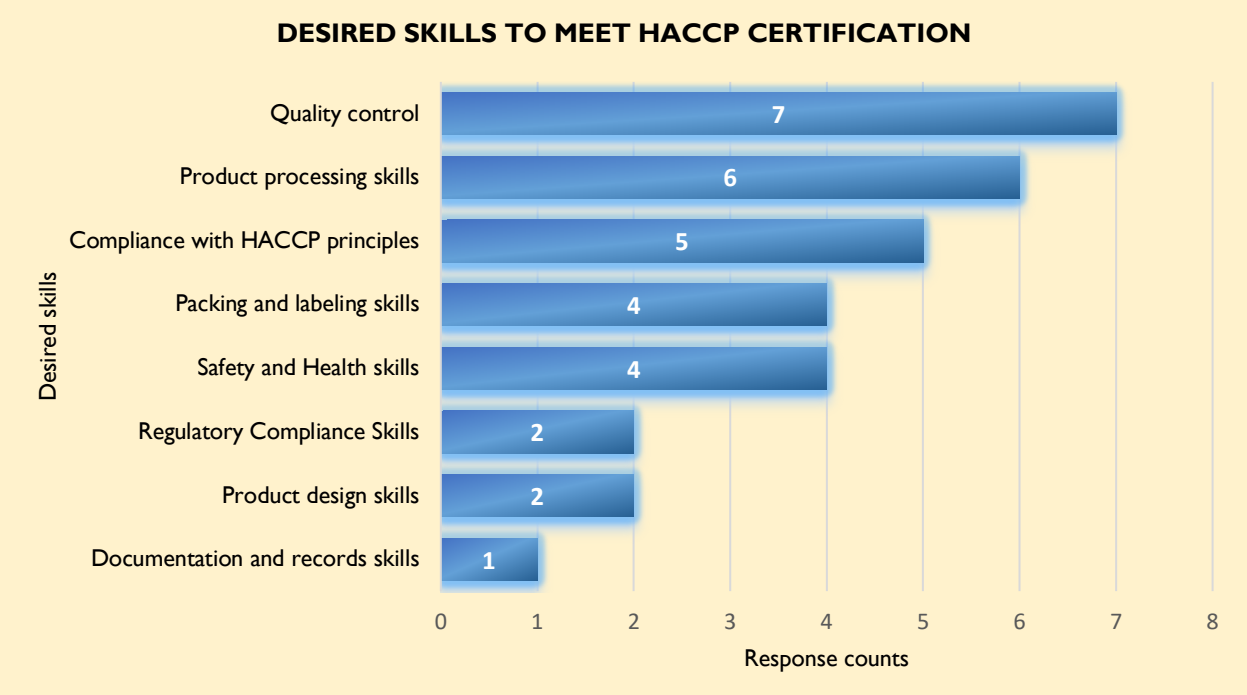
Globalisation together with advances in ICT, and the associated increase in intra-industry trade, has increased specialisation of production. As firms become more specialised, the requirement is for a higher level of technical skill in the workforce and management. Some employers interviewed expected that in the future, there is the inadequacy of a sufficient supply of high quality and relevant skills at all occupational levels and continuing up skilling in manufacturing industry occupations to meet firms operational and strategic needs. The focus will be on quality assurance and regulatory aspects and the design process and management of the production line (Figure 6.2.a). Competitive manufacturing uses high technology and R&D and intangible investments (training, improvements to business process) to support innovation. It will include substantial progress on innovation and productivity improvement, enabled by skills.

Figure 6.2.a: Required skills to meet product quality standards



Source: Customized from primary data collection, 2020

Figure 6.2.b: Desired skills to meet HACCP certification



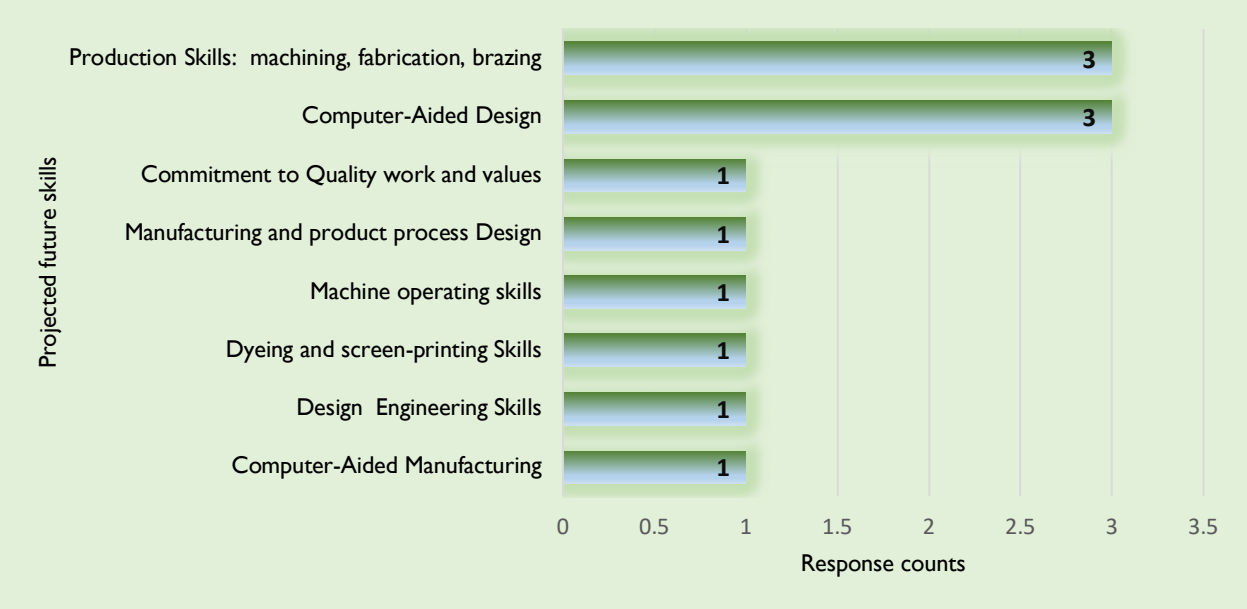
Source: Customized from primary data collection, 2020

6.3 Future Skills for Key Occupations

Strong people skills and generic skills have become essential across all manufacturing occupations, driven by the requirements of competitive manufacturing. The sector is heavily influenced by developments relating to advanced manufacturing technologies, such as:

- the growing 'computerisation' of production processes, as well as the prevalence of Computer-Aided Design (CAD) and bespoke software solutions;
- an increase in the resources required to test and inspect new products, as more complex materials and smaller components are used in production processes;
- a shift to shorter production runs and more customised products is driven by customer demand and facilitated by new manufacturing techniques such as 3D printing and plastic electronics.

Figure 6.3: Projected Future Skills to deliver on Business Strategies



Source: Customized from primary data collection, 2020

Employers perceive that these changes will continue to significantly impact the skills required from workers in the key occupations through:

6.3.1. Production managers in manufacturing

There is anticipated to be a general shift towards production managers requiring more business-related skills. However, employers reported facing a significant challenge in ensuring staff with both the business skills and technical production skills perform their role effectively.

The consensus among employers is that the role of production managers in manufacturing will shift to becoming more focused on supply chain management, purchasing, contract negotiation, and large-scale project management. This is partly due to the complexity of new product components (meaning that one individual is unlikely to understand how all the components in a product work) and the growing trend of outsourcing production to supply chain companies, which are better equipped to specialise in developing niche components.

In the future, production managers in manufacturing will also need to dedicate more time to continuous professional development to keep abreast of the latest sector developments. This may require a step-change in how managers think about their role. New technologies such as composites and nanotechnology are increasing the pace of change in the sector. New materials that can be used in production are being created every year due to these technologies.

6.3.2 Biological scientists and biochemists

New digital technologies will make clinical trials less labour intensive, consequently freeing biological scientists and biochemists to focus on other tasks. This will likely mean that workers in the future will be investing more time in R&D to develop new products. Employers will also benefit from new business opportunities as large-scale trials become more feasible as they will be less costly.

To develop new innovative products, employers will be aiming to recruit graduates with detailed knowledge of particular technologies. This is likely to result in an increasing need for specialist knowledge among new entrants. A growing number of employers expect students to gain a master's or postgraduate degree before entering the sector. The search for high-performing students is likely to make the Rwandan workforce even more international. In the future, there is expected to be a high demand for biotechnologists and biochemists working within manufacturing industries. For example, the potential use of bioscience products in the metal coating will lead to more biological scientists and biochemists working in the automotive industry. This brings a need for biological scientists to develop their knowledge of different industries to apply their scientific skills effectively in different environments.

6.3.3 Production and process engineers

Production and process engineers will in the future require a broader understanding of different production methods as employers diversify their offer to meet increasing customer demand for customised or bespoke products. This will increase demand for continuous professional development training and self-learning.

The increasing complexity of production methods and growing use of sub-contracting will require production and process engineers to require more excellent skills in project management, supply chain management, and maintaining quality across multiple manufacturing sites.

As with biological scientists, increasing future investment in R&D will likely increase demand for graduates with masters and postgraduate degrees. Some employers, particularly larger companies, will increasingly recruit high-performing graduates from outside Rwanda to meet skills shortages.

Production engineers are also expected to play a key role in supporting industrial biotechnology in the future. This requires production engineers to know biology, genetics, and microbiology to manage more varied production methods.

6.3.4 Metal working production and maintenance fitters

In the future, software development skills will become an increasingly important part of maintenance fitters' role. Some employers are likely to employ specialist software engineers in their maintenance teams to perform specific diagnostic assessments and repairs to machines. New types of maintenance fitting jobs are likely to be created in the future following the production process's growing automation. Technologies such as 3D printing and silicon technology are also likely to result in more complex machines being employed, requiring regular maintenance and monitoring, boosting employment in certain areas even if the overall number of maintenance fitter jobs falls.

In the future, maintenance fitters' role is expected to become more service-focused, as manufacturers outsource more complex machine calibration and system settings to specialist machine maintenance companies. This will result in maintenance fitters requiring more incredible skills in customer service, relationship management, and a broader understanding of the application of manufacturing equipment.
Some jobs in the future may be replaced by assembler or machine operator roles for metal workers, following the increasing use of laser cutting and 3D printing. However, the level of skills required by metal workers is likely to increase, as a more significant proportion of jobs will develop more specialist, customized products.

6.3.5 Assemblers (electrical and electronic products)

Although in future technologies such as 3D printing and plastic electronics will be commonly used in the sector, the skills required from assemblers are not expected to change significantly. New technologies primarily result in fewer components requiring assemblers, but it is expected that components will be joined through traditional methods such as soldering.

Demand for assembler roles is expected to decrease in the future as the use of laser cutting tools and growing automation of production lines will mean that new products will require less preparation and can be more easily slotted together. However, this will be balanced by increasing jobs for technicians to design and develop new products using machine tools. There will still be niche and specialist manufacturers that will continue to require assemblers to develop hand-crafted products. Assemblers will need to understand how components work and have high technical craft skills as these products will be more complex to assemble.

6.3.6 Future required Soft Skills (Generic Skills)

Manufacturing or production engineers and scientists require significant people and technical skills, such as quality engineering, validation engineering, supply chain engineering, and customer site engineering. In addition, engineers and scientists are often among the key people to lead lean manufacturing projects or to be included in lean manufacturing project teams; they need strong people and generic skills, including strong leadership and strategic management skills, for these roles.

In addition to meeting technical skills requirements, operatives in a competitive manufacturing environment need the skills to undertake fundamental problem solving, coordination, documentation, and process management responsibilities. Furthermore, as lean manufacturing typically involves working in a team environment, business communication, problem-solving, strategic thinking, supervisory management, commitment to quality work strategic management are essential.

Technicians and skilled tradespeople will require technical responsibilities and a formal leadership role (for example, shift supervisor), demanding a higher level of people skills than necessary for operatives. The pace of technological change and the constant evolution of manufacturing processes and supply chains further highlights the need for businesses to acquire strategic management skills and tactical production skills to keep pace with change in their external environments. There is a wide range of other management skills that will be required related to, amongst other things, the management of supply chains, human resource management, and the management of innovation.

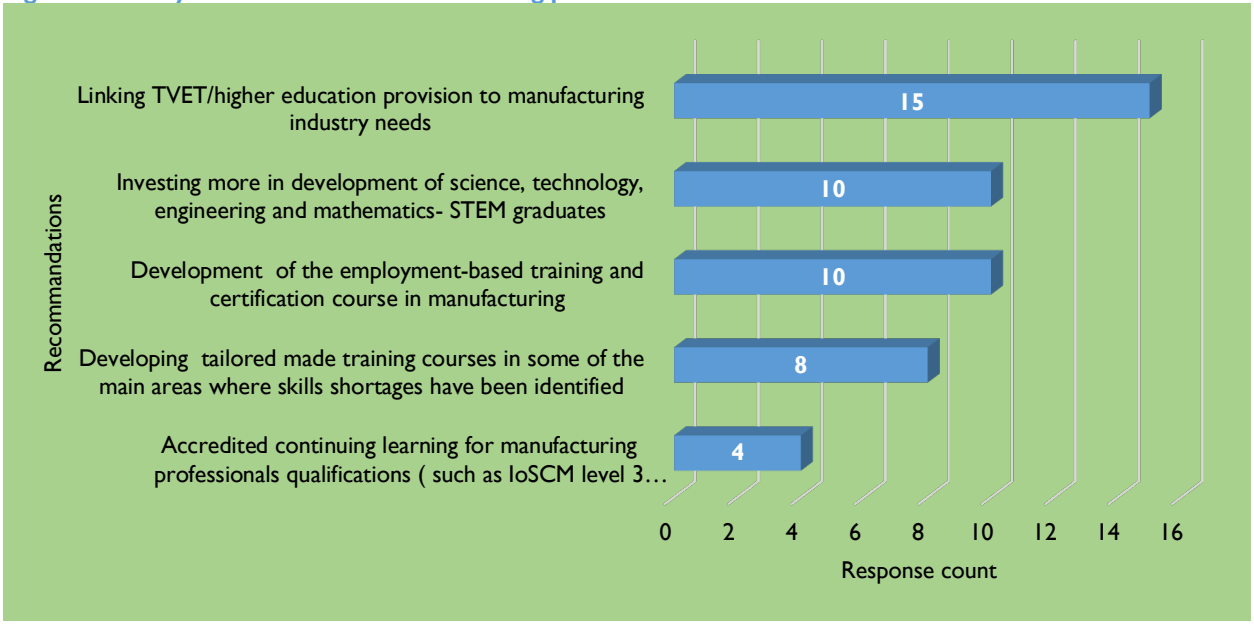
6.4 Implications for Skills Supply

Employees involved in lean manufacturing improvement projects will require training in production and process techniques required. Training to contribute to process improvement linked to these levels is

available from several Integrated Polytechnic colleges, College of Science and Technology, Universities, and private training providers.

In recent years, within higher education, there has been a significant increase in enrolments from 2012 in Science, Technology, and Engineering (STEM) disciplines relevant to the manufacturing sector. Therefore, an increased outflow of STEM graduates to the labour market can be expected in the coming years.
As well as core engineering skills, employers emphasised the importance of graduates being reasonably ready for work, both in terms of applying what they have learned and the course content reflecting the workplace as it is now. Firms reported collaboration between manufacturing industries and training providers to produce graduates with relevant manufacturing industry skills (Figure 6.4).

Figure 6.4.: Ways of Collaboration with Training providers



Source: Customized from primary data collection, 2020

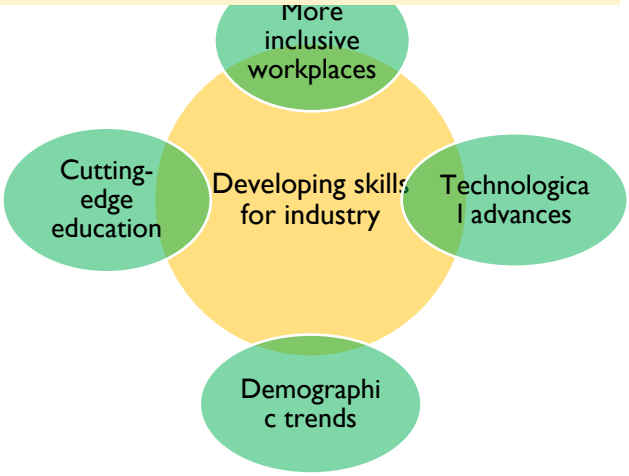
Firms highlighted the value of problem-based learning as a strategy for ensuring that engineering students learn to apply theoretical knowledge effectively and noted that it is resource-intensive, making it challenging to implement under current resource constraints in higher education. Some employers indicated that manufacturing excellence strategies such as lean manufacturing have become so universally important to the industry that all courses supplying engineering graduates likely to work in manufacturing should include at least a module on the topic, including some practical experience.
They highlighted many engineering specialisms currently in demand and in which firms have vacancies that they are having difficulty filling. These include: (i) Validation engineering; (ii) Quality engineering; (iii) Polymer engineering; (iv) Automation engineering; and (v) Supply chain engineering.

Firms reported that other professional-level engineering specialisms that support manufacturing should be satisfied through qualified and experienced engineers undertaking further study in the area to develop the specialist skills needed. Postgraduate diplomas and taught master's courses in these areas are more appropriate for the skills needed than undergraduate courses.

6.5 Sector Skills Response to address the skills gaps identified

Figure 6.5: Key Factors of Influence for Skills Development

6.5.1Key Factors of Influence for Skills Development



6.5.2 Acquiring New Skills and Competencies

Figure 4: Acquiring New Skills and Competencies

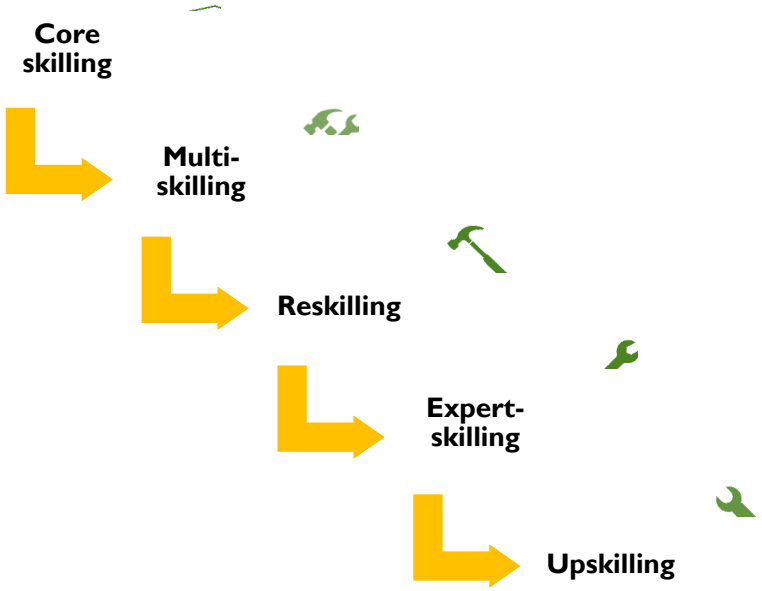
Source: Customized from World Manufacturing Forum Report, 2(

6.5.3 Continuing Learning and Development

Skills development enables and enhances a person's ability to learn new technical skills, becoming increasingly important. An employee who can work with both front-end and back-end technologies is often preferred over a person with expertise only in one area. Multi-skilling (or cross-skilling) can provide enterprises with more flexibility and resilience while increasing the intellectual capital and morale of the workers. During the interviews, it was noted that employees with higher education tend to learn faster and be more adaptable than those with secondary or vocational education. While technological advances provide companies with new opportunities for value creation, the real benefits can only be realised when the companies also possess the right skills and expertise to learn and use new technologies. Therefore, expert skilling is necessary to go in-depth (as opposed to breadth with multi-skilling) and capitalise on these specific technologies. Such technical skills are often non-transferable and require vocational or on-the-job training, for example, apprenticeships and internships, as they can only be obtained through hands-on practice and experience. While off-the-job training can deliver most core skills, on-the-job training is more effective for problem-solving and teamwork skills[44].

[44] Green, F., Ashton, D., Felstead, A. 2001. Estimating the determinants of supply of computing, problem-solving, communication, social, and team working skills. Oxford Economic 53(3), pp. 406-433.

Figure 6.5: Continuing Learning and Development

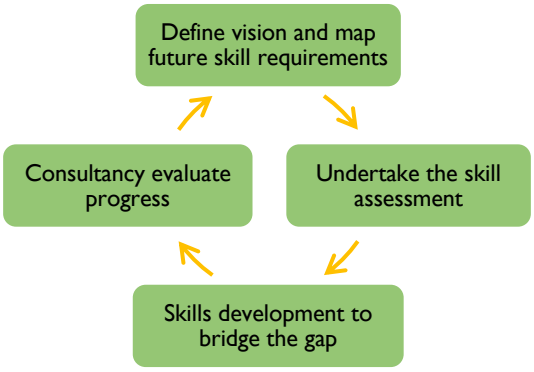


6.6 Lesson for Manufacturing Sector in Rwanda

Within sustainable Human Resource Management, manufacturing industries can enhance their employees' preparedness for the future and leverage people's strengths by going iteratively through the four macro-phases of the skill cycle and key features of a practical skill assessment.

Phases of the Skill Cycle in the Manufacturing Sector

Figure 6.6.1: Skills Life Cycle



Source: Customized from World Manufacturing Forum, 2019

CONCLUSION AND KEY RECOMMENDATIONS

7.1 Introduction

This section presents the research's key findings and conclusions and offers recommendations based on them.

7.2 Conclusion

Rwanda has made great strides in using structural transformation to drive its growth and job creation. The importance attributed to transforming Rwanda's economy from low productivity sectors like agriculture to high productivity sectors such as manufacturing stems from the realization that "sustainable high growth and employment creation is almost always achieved through structural change towards increased manufacturing production.[45]" This process has pulled workers out of subsistence agriculture into industries without smokestacks as well as incipiently manufacturing industry. Manufacturing, though still small, is becoming a dynamic complement to the industry growth process. This process creates a demand for ever higher skilled labor. While manufacturers complain even today that the lack of availability of skilled workers inhibits the growth of the manufacturing sector, the aggregate numbers in the country aspirational scenario and value chain analysis show that this gap is likely to be case in the decades ahead. Thus, the employers must rapidly invest in their workers and innovation to sustain the manufacturing industry's growth momentum, lest the lack of skilled workers and professionals become a brake on growth.

The assessment shows that there are significant business benefits to employers from investing in the skills of their workforce, but a better way to consider this issue in relation to manufacturing is with the respect to the costs of not investing in skills development. The ultimate reason is to encourage manufacturing employers in general towards being advanced manufacturers. The rewards of doing so are substantial not least the capacity to survive in a global market where low value manufacturing is increasing outsourced to countries with lower production costs. The evidence presented in this report suggests that if private manufacturers invest in skills, they will obtain significant gains from doing so. It is also apparent that there is a substantial training and skills infrastructure which manufacturing companies can make use of in raising the level of skills in their workplaces.

[45] GoR, Rwanda Industrial Capacity and Performance

Within manufacturing there is a well-established pattern of products shifting over time from being small-scale batch manufactured products to mass produced commodities. The skills required at different stages in the product life cycle are not necessarily the same: from small-scale production and the emphasis upon design and design for manufacture at the beginning of the product life cycle-and associated skill requirements-to the move to mass production at the latter stages with, perhaps, production being transferred abroad leaving behind a substantial R&D and design presence. The evolving business styles associated with different stages of the product life cycle are a particular skills challenge for all businesses in the manufacturing sector.

The SSA report highlighted that the skills required by the manufacturing workforce are rapidly changing. The speed of change is increasing and forcing supply chains to become more like supply networks requiring higher levels of flexibility, agility and a broader spread of soft skills across the manufacturing workforce. Higher levels of personnel responsibility, autonomy and managerial delegation will be required at all levels in the manufacturing firms. For instance, because of the digitization of manufacturing, tasks are becoming increasingly automated. Furthermore, advanced technology adoption will only produce optimal results if workers have the necessary skills to work alongside them. On the other hand, Workers should recognize the importance of training and take steps to enhance their abilities as needed. Likewise, the training and development of employees should be a major concern for manufacturing enterprises. Skills and training providers would have to make sure that the proper skills are being taught.

In summary, to address the skills gaps, all manufacturing industry stakeholders must adopt a new mentality and show tremendous dedication. The sooner the industrial community recognizes the seriousness of the issue and all stakeholders come together to address this industry-wide problem, the better prepared it will be to deal with the skills deficits. The review of policies and programs offers a source of optimism. The government has developed a sophisticated set of policies to use skill development, business creation, and job matching to alleviate any skills deficit and constraint on growth. The challenge ahead will be to realize the potential of these programs.

7.3 Key Recommendations

In developing recommendations, it is clear that the skills need in the manufacturing sector are broad and, in some instances, complex. Addressing skills needs, the assessment recommended the actions in Table 7.3. PSF will spearhead implementation of these recommendations by coordinating all stakeholders relevant looking at their roles:

Table 7.3: *Recommendations*

No	Recommendations	Responsible	Timeframe
1	Investing in upskilling and developing the existing workforce to ensure that they are capable of taking advantage of new technologies	Manufacturing Companies, NIRDA, RDB, MIFOTRA, Rwanda Association of Manufacturers (RAM)	Short –term
2	Investing more in the development of STEM graduates and ensure that technology skills are embedded at the heart of a wide range of STEM-related	MINEDUC, RP/IPRCs/ TVET, Universities, other Training providers	Medium – term

No	Recommendations	Responsible	Timeframe
	programs		
3	Setting up a clear national framework for skilled trades level training and review the National Framework of Qualifications accordingly	MINEDUC, RP/IPRCs, RDB, RAM	Medium Term
4	Developing and Delivering tailored made modules/training courses, accredited work placements, or amending the curriculum within the education and training system to ensure that graduates produced and TVET leavers have relevant industry skills	MINEDUC, RP/IPRCs/TVETs, RDB	Medium Term
5	Establishing an accredited continuing learning system for manufacturing professionals' qualifications or Certification (such as IoSCM level 3 Manufacturing and Production)	RAM, NIRDA, RDB, MINICOM	Medium Term
6	Institutionalize continuous professional development (CPD) and work-based learning programs	RDB, Manufacturing Firms, MINICOM, NIRDA	Long term
7	Linking TVET/RP and Higher education provisions to manufacturing industry needs	MINEDUC, RDB, NIRDA, MINICOM, RAM	Long term
8	Institutionalise research and innovation development in advanced manufacturing industries	NIRDA, PSF, MINICOM, Pharmaceuticals, chemicals, food, and beverages industries	

7.4. Policy actions

In additional to the above recommendations, following policy actions are helpful towards creating an educated and skilled manufacturing workforce now and in the future.

Table 7.4: Policy actions

Policy action	Brief Description
Ensure that industry relevant skills are being taught	Systematically involve industry in updating curricula in schools; Support real-world experiences for students; Ensure teachers and instructors are up to date with industry developments
Increase investment in Workforce education to reach the full potential of new technologies	**Manufacturing c**ompanies should treat workforce training and education as a priority; Leverage human-centric skills that complement technology;
Create a manufacturing market with a life-long learning mindset	Workers should proactively seek out life-long learning opportunities; Create personal and professional incentives for workers to engage in training; Empower workers by letting them participate in training design.

Policy action	Brief Description
Use digital technologies to innovate delivery of education and training	Utilize collaborative platforms to share knowledge and best practices; Use technology to help overcome physical, cognitive, and other barriers to learning; Leverage digital tools to make learning possible anytime and anywhere.
Elevate the value of Vocational-Technical Education and Training pathways	Promote vocational-technical education to complement formal education; Encourage cooperation between vocational-technical training and formal education providers; Increase the quality of vocational-technical training-related jobs.
Foster collaboration to address Skills Development needs	Set aside competition to cooperate on industry-wide skills initiatives Share knowledge and best practices on workforce education Harness the potential of industry and trade associations to promote skills development

Source: Customized from World Manufacturing Forum (2019) recommendations and from primary data collection, 2020

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ANNEXES

ANNEX I: List of manufacturing firms consulted

C/N	Name of Companies	Sub-sector
1	Utexrwa Rwanda	Textile
2	Kigali Leather Ltd	Leather products
3	Rwanda Clothing	Cloth
4	C&D Products Rwanda Ltd	Garments
5	SOSOMA Industries Ltd	Food products
6	Kinazi Cassava Plant	Cassava
7	Food Nutri Health Mgt Ltd	Food products
8	G-MART Limited	Chemicals, school chalks
9	Rwanda Plastic Industries	Plastic Products
10	Cooper Pharma Plant -Rwanda	Gasabo , Prime Economic Zone
11	Sulfo Rwanda Industries	Cosmetics, Plastics, Detergent, Carton and water
12	Wood Habitat	Wood
13	Right Click	Printing
14	Sawmill East Africa Ltd	wooden products,
15	Rwanda Printing and Publishing Company Ltd	Printing
16	Gisagara Banana Plant	Gisagara District
17	Skol Brewery Ltd	Beverages
18	BAT Rwanda	Kicukiro District
19	CIMERWA	Ciment
20	East African Granite Industries	Slabs, Tiles, Granite blocks
21	Chillington Rwanda	Spare in iron or in steel
22	Ruliba Clay Ltd	Bricks, wall blocks, ventilators
23	Master Steel Ltd	Steel bars, roofing tiles, galvanized sheet
24	REMCO - Rwanda Engineering and Manufacturing Corporation	Manufacturing machine, equipment
25	Sahasra Electronics Rwanda Pvt.ltd	Lights
26	Rwanda Motorcycle Company - RMC	Kicukiro District
27	Manumetal Ltd	Wood, steel and solar furniture
28	AMEKI Color Ltd	Paints, furniture and tanks
29	ADARWA	Wood Product
30	Crown Paints Rwanda Ltd	Nyarugenge Kigali (export Kenya)
31	Aquasan Ltd	Plastics
32	Bems Duhange	Tiles, blocks, Cobblestones
33	Kigali Cement Company	Cement
34	Maraphone	Phones
35	PHARMA LAB Ltd	Vacuum Tubes
36	Papyrus Co. Ltd	Office, Home Furniture
37	Positivo BGH Group	Computers, Laptops, Cash power
38	Safintra	Roofing sheets in painted and unpainted
39	Supa Works	Tissue Paper
40	Atlas Windows	PVC Window & door frames
41	Great Lakes Cement	Cement
42	KIGALI PLASTICS	Tubes, pipes and hoses, rigid polymers of vinyl chloride
43	Seven hills Ltd	Aluminum Utensils
44	Soimex Plastic Ltd	Fabrication of Construction materials, agriculture, hygiene and even packaging
45	Sonatubes	Lightning Protection Products

ANNEX II: List of Stakeholders consulted in MDAs:

1	Ministry of Trade and Industry (MINICOM),
2	Rwanda Development Board (RDB),
3	Rwanda Standard Board (RSB),
4	National Institute of Statistics of Rwanda (NISR),
5	Ministry of Finance and Economic Planning (MINECOFIN),
6	Ministry of Agriculture and Animal Resources (MINIGRI),
7	National Agriculture Export Board (NAEB),
8	Food and Drug Authority (FDA).
9	Rwanda Polytechnic
10	TVET institutions (IPRSCs, TVET),
11	High Learning Institutions (HLIs) : UR and CST