

WHITEPAPER SUMMARY

Skill Development for Industry 4.0

BRICS Skill Development Working Group

Introduction

The manufacturing industry is currently witnessing the fourth industrial revolution, better known as Industry 4.0 where the 'real' and the 'virtual' world are to be seamlessly connected giving rise to what are known as cyber-physical production systems. As a result, the traditional manufacturing processes are undergoing an enormous transformation which will change the way companies approach manufacturing.

Industry 4.0, which started off as a brainchild of Germany, is being adopted by countries around the world. Developed nations like USA, France and Japan have already taken the first step in this direction by launching nation-wide programs. The adoption of Industry 4.0 by developed nations presents significant threat to the BRICS nations as it will result in job migration from the BRICS nations to the developed nations. In order to maintain global manufacturing competitiveness, each of the BRICS nations needs to actively participate in this fourth industrial revolution.

In their journey to adopt Industry 4.0, each of the BRICS nations is expected to encounter a number of challenges related to skill level of their work force. For instance, the skills which are considered important today will cease to do so in the future and the work force will be expected to possess new skills in the domain of information technology, data analytics, etc. A higher percentage of the jobs will give importance to cognitive abilities and system skills over physical abilities while defining core work-related skill sets.

In most BRICS nations, there exists a mismatch between the skill sets job applicants have and the skill sets they are expected to possess. In the scenario where Industry 4.0 technologies have been widely adopted, this demand-supply gap will widen even further if necessary actions are not taken by each of these countries. Though the governments of the BRICS nations have undertaken independent initiatives to promote vocational education and skill development in their countries, there are still significant efforts required for focusing on skill development for Industry 4.0. There exists an opportunity for the BRICS nations to collaborate for skill development and work together to prepare their work force for Industry 4.0. This report aims to address this issue and recommend numerous ways of collaboration.

The report has been divided into 3 sections. The first section gives a brief overview on Industry 4.0 and assesses the current level of Industry 4.0 adoption in the BRICS nations and compares it with the adoption levels in the other developed nations – specifically Korea, Japan, Germany and USA. The second section evaluates the current skill levels in the BRICS nations, skill sets required for Industry 4.0, challenges faced in skill development, various skill development initiatives undertaken and existing bilateral collaboration. The third section presents a set of recommendations to enable collaboration among the BRICS nations to address the issue of skill development for Industry 4.0. The recommendations cover a wide range of initiatives like collaborating for curricula development and training the trainers, hosting skill competition, jointly developing skill training methodology and standardizing qualification framework to name a few.

1. INDUSTRY 4.0 – IMPORTANCE FOR BRICS

OVERVIEW

Industry 4.0, christened so based on its promise as the fourth industrial revolution, encompasses a wide spectrum of technological advances across the value-chain. Industry 4.0 technologies – Automation / Robotics, Internet of Things, Artificial Intelligence, Additive Manufacturing, etc. – are revolutionizing the traditional manufacturing processes. And as a result of increased use of digital technologies, the boundary between the real and the virtual world is increasingly blurring, giving birth to what are known as cyber-physical production systems. Several Industry 4.0 technologies have gained or are gaining prominence. However, a 'Smart Factory' or Factory 4.0 that leverages all key tenets is not yet very common.

Industry 4.0's primary appeal lies in its ability to act as an economic game-changer for companies through greater manufacturing flexibility to meet varied demand from customers but also help companies in reducing the lead time for prototypes through technologies such as mass customization and 3D printing. Industry 4.0, which started off as Germany's brainchild, is also expected to minimize the labor cost advantages of traditional low-cost locations, making it attractive for manufacturers to bring previously offshored jobs back home.

Industry 4.0 has come into geo-political focus, garnering attention from national governments. Countries across the world have pioneered full-

fledged national missions to be a part of this fourth industrial revolution – *Industrie 4.0* in Germany, *Advanced Manufacturing Partnership 2.0* in USA, *Revitalization and Robots Strategy* in Japan, *Industrie du Futur* in France and *Intelligent Factories Cluster*s in Italy, to name a few. To ensure sustenance of manufacturing competiveness, emerging markets have also initiated the adoption of next generation manufacturing through the launch national strategies – most notably, China had launched 'Made in China 2025' to promote Industry 4.0, India had initiated the 'Make in India' mission to promote manufacturing, Russia had issued a program called the 'Development of the manufacturing industry and improvement of its competitiveness for the period till 2020'. While Brazil and South Africa do not have a national strategy, several initiatives across robotics and Industry 4.0 have been undertaken.

CURRENT STATUS OF ADOPTION OF INDUSTRY 4.0 IN BRICS

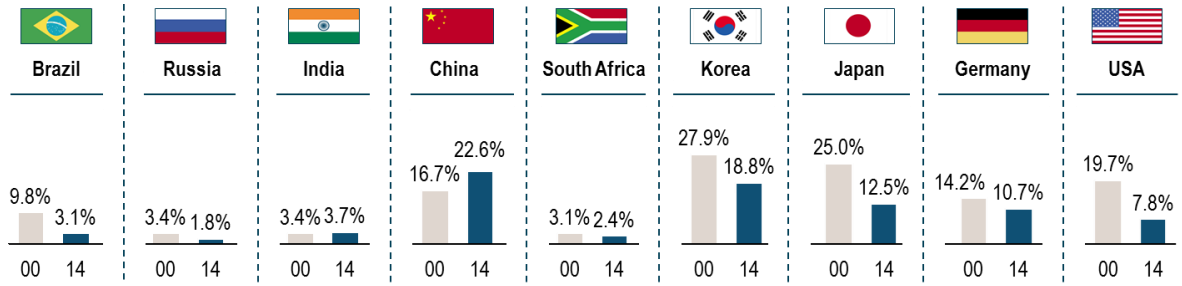
In the last decade, BRICS nations have gained significant traction in the world economy as producers of goods and services, receivers of capital and potential consumer markets. They have been recognized as some of the fastest growing nations and have come to play an important role in the global economy. This is in contrast to the developed nations where the growth has stagnated – between 2000 and 2014, the GDP of Germany, USA and Japan grew by 2% 1% and 0.4%, respectively[1].

Figure 1 - Key facts, 2014

Parameter	Brazil	Russia	India	China	South Africa	Korea	Japan	Germany	USA
Gross Domestic Product (GDP)	$1,206 Bn	$1,000 Bn	$1,573 Bn	$5,302 Bn	$328.7 Bn	$1,239 Bn	$4,781 Bn	$3,227 Bn	$14,682 Bn
Share of Global GDP	2.1%	1.7%	2.7%	9.1%	0.6%	2.1%	8.2%	5.5%	25.2%
Share of Manufacturing in GDP	12.1%	14.0%	18.4%	35.4%	14.6%	29.8%	20.9%	21.3%	12.3%
Share of Global Manufacturing GDP	1.5%	1.4%	3.0%	19.1%	0.5%	3.8%	10.2%	6.9%	17.4%
Share of Manufacturing in Exports	29.0%	15.5%	43.5%	89.0%	41.3%	70.1%	74.7%	67.1%	42.9%
Labor Force	109.8 Mn	76.8 Mn	497.0 Mn	806.5 Mn	20.0 Mn	26.4 Mn	65.3 Mn	42.2 Mn	161.1 Mn
Hourly compensation (2015)	$11.9	$2.5	$1.9	$6.4	$5.8	$17.2	$21.9	$42.6	$36.1

Source: World Bank; United Nations Statistics – National Accounts

Figure 2 - Share of High-tech exports in total exports, 2000 & 2014



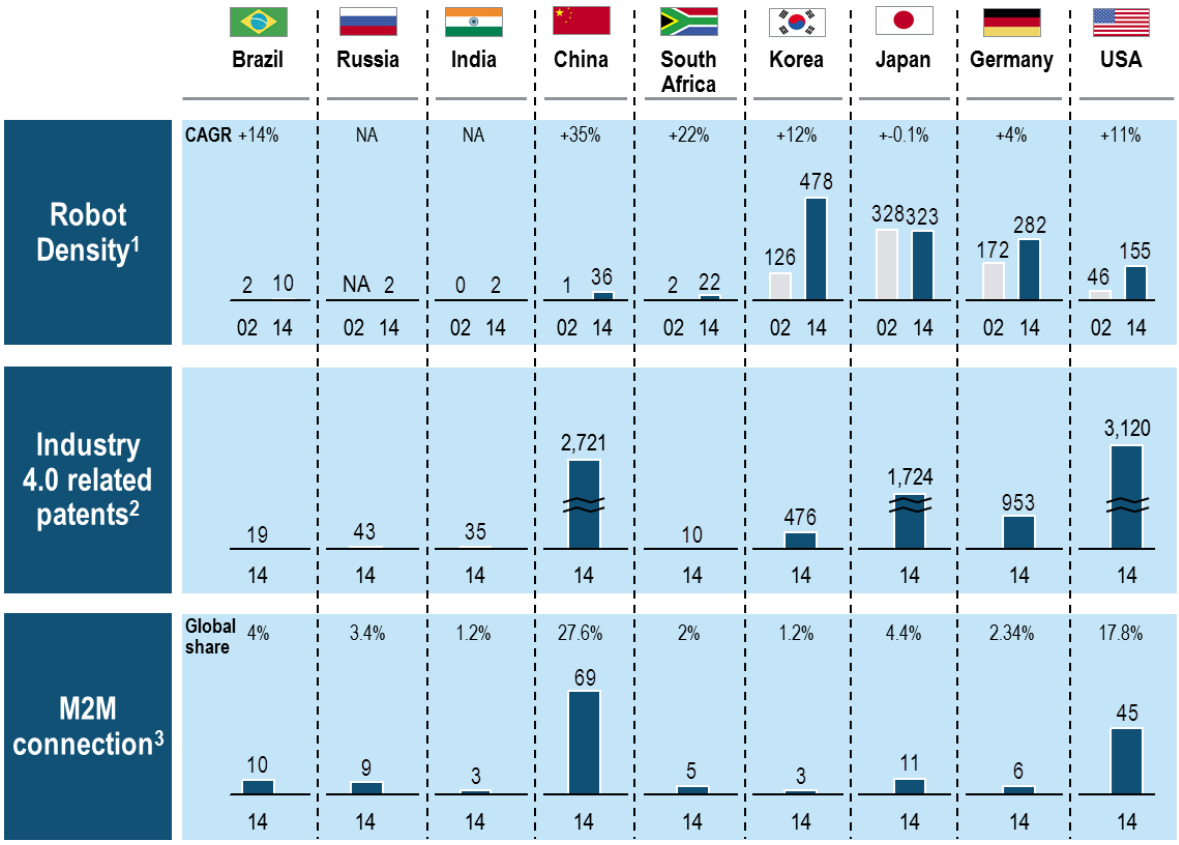
Source: World Bank

BRICS's contribution in global GDP and global manufacturing value add has increased from 8.7% and 13.2, respectively, in 2000 to 16.2% and 25.4%, respectively, in 2014[1]. Among the BRICS nations, China and India have also seen an increase in share of high tech exports in total exports of a country (from 16.7% to 22.6% for China and from 3.4% to 3.7% for India[2]).

The rise in contribution of BRICS nations was supported by easy availability of a large and lower cost labor force in BRICS nations, resulting in improved manufacturing competitiveness at global level and incentivizing firms from developed nations to set up local manufacturing plants. China and India further emerged as important destinations due to their huge populations and large unpenetrated domestic markets. However, the cost differential is narrowing with most of the BRICS nations witnessing significant increase in manufacturing costs, primarily due to increasing wages. Between 2002 and 2015, the hourly compensation cost in manufacturing increased from USD 3.1 to USD 11.9 for Brazil, from USD 1.4 to USD 2.5 for Russia, from USD 0.7 to USD 1.9 for India, from USD 1.0 to USD 6.4 for China and from USD 4.9 to USD 5.8 for South Africa.[3]

With the expected reduction in cost arbitrage and increasing need for flexibility (e.g. mass customization), it is important for BRICS nations to adopt advanced manufacturing technologies to remain competitive in the global market. BRICS nations, other than China have low levels of industrial automation (robot density), low numbers of Industry 4.0-related patent applications, low numbers of machine-to-machine connections and limited activities in robotics and additive manufacturing by companies, which is an indication of low levels of Industry 4.0 readiness. Most of these countries will have to leapfrog certain aspects of industrial automation to get to the extent of connected systems defined in Industry 4.0

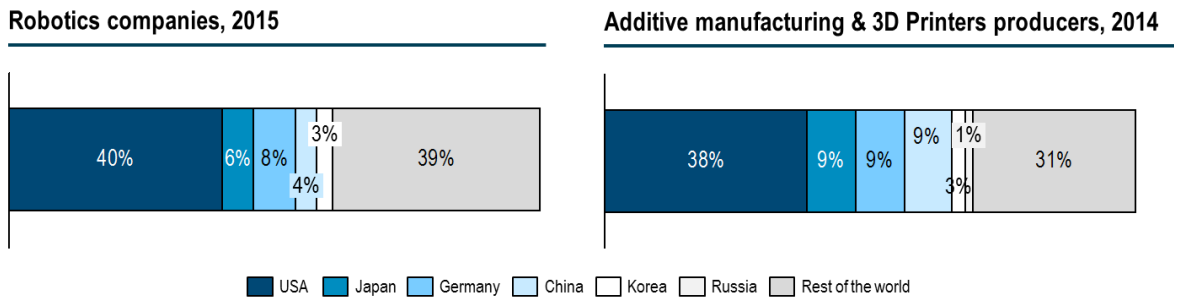
Figure 3: Comparison of BRICS vs. Developed Economies



Note: 1. Robot Density is defined as number of industrial robots per 10,000 employees. 2. Industry 4.0-related patents have been assumed to be registered in 4 major patent categories – H04L (Transmission of Digital Information), B25J (Industrial Robotics), B29C (Shaping or joining of plastics) and G05B (Control & Monitoring Systems). 3. M2M connections are defined as SIM connections that enable mobile data transmission between machines. It does not include SIMs used computing devices in consumer electronics such as smartphones, dongles, tablets, e-readers, routers or hotspots

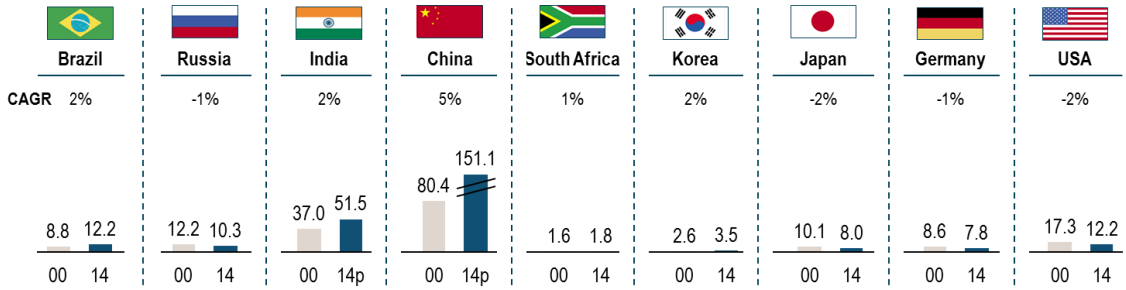
Source: International Federation for Robotics; Ministry of Economy, Trade and Industry (Japan); WIPO; USPTO; GSMA Intelligence

Figure 4 - Regional distribution of Industry 4.0-related technology companies



Source: WIPO; Directorate General for Internal Policies, European Parliament

Figure 5 - Manufacturing workforce, 2000 & 2014 (Mn)



Source: ILO Stat; Oxford Economics; China Statistical Yearbook; Korean and Japanese Ministry of Labor; US BLS; DE Statis

At present, each BRICS nation is working on improving the readiness for Industry 4.0 and driving quicker adoption. China has been leading with the launch of Made in China 2025 plan, Brazil is developing its advanced manufacturing policy. Russia is promoting individual Industry 4.0 technologies through its TechNet initiative. India is promoting manufacturing and use of ICT through launch of Make in India and Digital India program, respectively.

At the same time, few independent initiatives have been launched to support Industry 4.0 adoption in BRICS nations. For instance, in Brazil, an industry-wide Industry 4.0 assessment has been carried out.[4] In Russia, a consortium has been set-up to assist the application of Industrial Internet.[5] In India, an educational institute has joined hands with a global aircraft manufacturer to establish a smart factory.[6] In China, a cell phone module manufacturer has completely automated its production lines in its Dongguan factory, which is now considered as an unmanned factory run by computer-controlled robots.[7] In South Africa, the public sector invests into research on additive manufacturing.[8]

However, a number of challenges, as listed below, hinder Industry 4.0 adoption.

- Massive upfront capital requirements and sizeable investments in R&D
- Low awareness and lack of clarity in defining return on investment
- Inappropriate and insufficient IT infrastructure, low information security
- Difficulties in integrating new hardware and software
- Lack of financial assistance and credit
- Below-the-expectation education and skill level of employees

WHY SKILL DEVELOPMENT IS CRITICAL FOR BRICS

In BRICS countries alone, around 227 Million people were employed in the manufacturing sector which is higher than the population of the 5th most populous nation (Brazil with 204 Million). In most BRICS countries more than 10% of the population depends on employment in the manufacturing sector with China having the highest dependency of 18.7%.

Adoption of Industry 4.0 will result in elimination of lower skilled jobs through automation and the increase in productivity could result in an overall reduction in the number of jobs available. With the increased automation levels, Industry 4.0 will result in job migration back to the developed economies which will result in further reduction of jobs in the low cost manufacturing countries.

Given high dependence on low skill labor in the BRICS (for example, only 2% of the labor in India is skilled[9]), re-skilling or up-skilling will be required by all the developing countries to make them ready for the new requirements. For countries like South Africa where the unemployment rate is close to 25%[10], such reduction in the number of jobs would further fuel the challenge. Similar case exists in India where around 10 million additional jobs per year are to be created by 2020 to ensure adequate opportunities for the young population.

2. SKILL READINESS OF LABOR FOR INDUSTRY 4.0 IN BRICS NATIONS

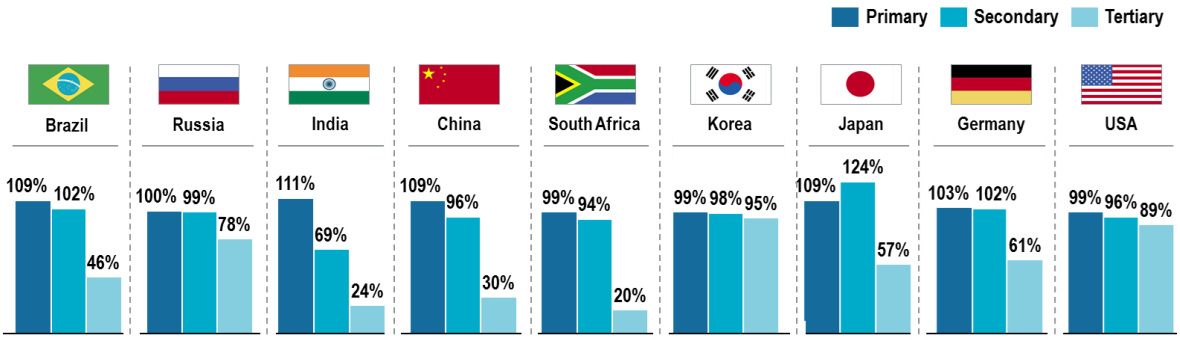
General education as well as vocational education have a critical role to play in making employees industry ready. They lay the foundation for skill development, which is critical for economic growth and social development of a country. BRICS nations, however, face a dual challenge of a lack of highly-trained employees and non-employability of a large section of the educated labor force due to skills mismatch.

The current skilling levels in BRICS nations can be evaluated by analyzing the Gross Enrolment Ratio (GER) at various levels of education and participation of students in vocational training (Figure 6).

At primary level, all BRICS nations have a high enrolment ratio of more than 100%. (A number more than 100% indicates that a number of students are undergoing grade repetition.) At secondary education level, except for India, which has a very low gross enrolment ratio of 69%, all other BRICS nations have a ratio close to 95% comparable to ratios in developed nations like Germany, UK, Japan and France. Sustaining the participation past the secondary education stage is a challenge which most BRICS countries face. At tertiary education level, only Russia, amongst the BRICS nations, has a GER comparable to that of developed nations. The enrolment ratio for India, China and South Africa is almost half or less than half of that in developed nations, which have gross enrolment ratios of around 60%.

In terms of participation in vocational education, the percentage of upper-secondary students enrolled in vocational courses in Brazil, India and South Africa stood at 8%, 3% and 12%, respectively.[11] A very small percentage of students entering upper-secondary education level opt for technical and vocational courses. Russia and China, however, have higher participation in vocational education at upper secondary level – 52% and 46% respectively.[11]

Figure 6 - Gross Enrolment Ratio at different education levels, 2013



Source: UNESCO Database

At these skilling levels, companies across the BRICS nations are facing challenges in finding skilled workforce at current skill levels. As per a survey conducted by Manpower Group, globally 38% of the employers face difficulty in filling job vacancies. While the difficulty is less in South Africa (31%) and China (24%) as compared to the global average, the challenge is higher for companies in Brazil (61%) and India (58%). Finding suitable candidates for job roles like skilled trade workers, technicians and sales representatives remains a big challenge with skilled trade workers being the most difficult to find for the last 4 years. Around 35% of the employers quoted lack of available applicants as a major reason for the difficulty experienced in filling jobs. 34% of the employers mentioned lack of candidates with required technical competencies (hard skills) as another reason while around 20% of the employers reported lack of experience and lack of workplace competencies (soft skills) as the other main reason for the same.

With the increase in adoption of advanced manufacturing technologies, the problem is bound to become even more severe if adequate structural changes are not put in place. Not only will there be a lack of manpower with the desired skill sets but employers will have to make high capital investment in re-skilling and up-skilling their existing workforce to suit their requirements.

SKILLS FOR THE FUTURE

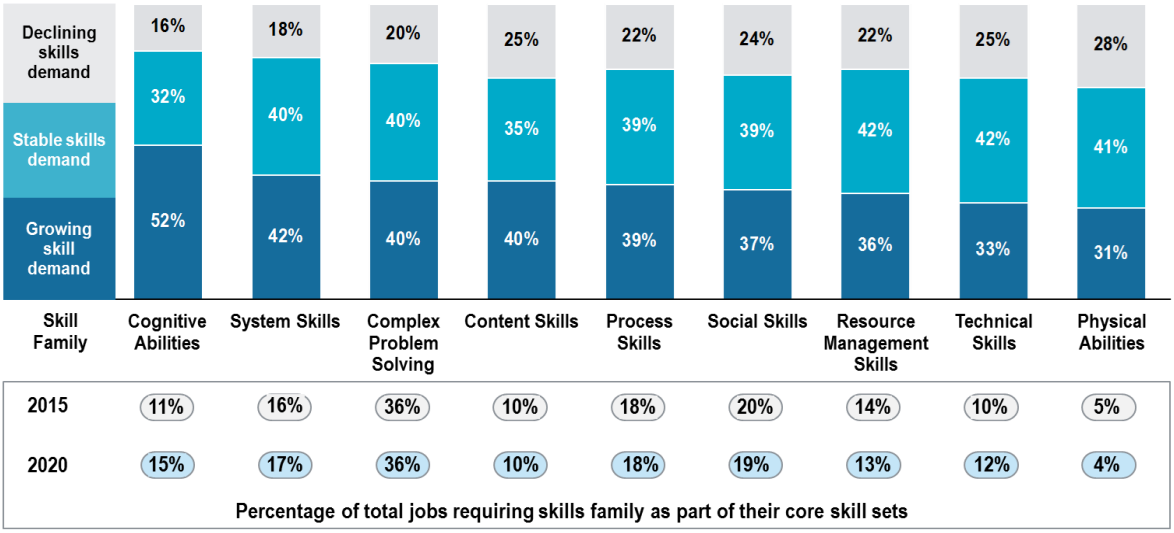
With the advancement in technology and gradual implementation of Industry 4.0 solutions, the skill requirement in industry is going to change significantly. It is very important to understand what changes Industry 4.0 will bring in the current manufacturing setup, what the new tasks that an employee would have to do will be, how it is going to be different from what he or she has been doing and what additional skills would be required to carry out those tasks successfully. Russia has developed an 'Atlas of Emerging Jobs' which lists down the occupations that are bound to get outdated and the prospective new jobs and their respective skill requirement.

The next industrial revolution will bring higher level of automation and interconnectivity in the manufacturing process. The tools, technologies and machines to be used are expected to be different from what is present today. Smart machines will coordinate manufacturing processes by themselves, smart service robots will collaborate with workers on assembly lines and smart transport systems will transfer goods from one place to another. Smart devices like tablets, wearables, etc., will be used to gather and analyze real-time information.

Information and data will be the key elements which the employees will have to process in their day-to-day jobs. People would be required to do less of manual work and more tasks of control and supervision of processes.

As per the 'Future of Jobs' survey conducted by the World Economic Forum, it is expected that a number of skills that are not considered to be significant in today's context will form one-third of the desired core skill sets of most occupations in 2020.[2] Such a shift in the skill requirement is expected with increased digitalization. With adoption of automation and artificial intelligence, a number of tasks involving technical skills like troubleshooting, quality control, etc., and resource management skills like people and time management would be eliminated. It is expected that the percentage of jobs requiring Technical Skills and Resource Management Skills as part of their core skill sets will go down from currently 14% and 14%, respectively, to 12% and 13%, respectively, in 2020. The percentage of jobs requiring Cognitive Abilities as a core skill will rise to 15%, from a current level of 11%.[12]

Figure 7 - Change in demand for core work-related skills



Source: Future of Jobs Survey, World Economic Forum

Though skills demand at an aggregate industry level is expected to evolve as mentioned above, the degree of change in skill requirements within individual job families is even more significant. For example, among all the jobs requiring cognitive abilities as part of their core skill sets, 52% of the jobs do not have such requirements now and are expected to have growing demand of cognitive abilities skill set by 2020. In 30% of the jobs, the demand for cognitive abilities skill set currently is high and is expected to have stable demand. The remaining 16% of jobs which require high cognitive abilities today will see a decline in importance of cognitive abilities. Cognitive abilities, system skills and complex problem solving skills are the top three skills expected to be high in demand and will continue to remain important.

CHALLENGES FACED IN SKILL DEVELOPMENT BY BRICS NATIONS

All BRICS nations have realized the importance of skill development in achieving economic growth in the future and have taken various measures to bridge the skill gap. From increasing education expenditure to increasing the network of vocational training institutes by establishing nation-wide programs, initiatives have been launched to make the labor force industry-ready. However, BRICS nations face a number of skill development challenges:

- **Demand supply mismatch**: There exists a mismatch between the skill sets job applicants have and the skill sets they are expected to possess, resulting in low employability among the youth.
- **Lack of access**: A number of students are unable to pursue vocational education due to lack of sufficient number of vocational schools and training institutes across the country
- **Lack of industrial training:** The vocational education in BRICS nations comprises of classroom based courses and apprenticeships are not included as a mandatory part of educational programs. As a result, students lack practical exposure, rendering them less competent
- **Poor quality**: BRICS nations also face challenges due to inflexible and outdated curricula, shortage of qualified teachers and trainers and unavailability of proper and up-to-date infrastructure
- **Lack of resources**: Skill development efforts are also hindered by lack of available funds

- **Negative image at secondary level**: The Vocational Education and Training (VET) track suffers from a negative image, i.e., VET is for school drop-outs rather than a way of training workers. The problem of negative image of vocational courses is much more severe at secondary level.

SKILL DEVELOPMENT INITIATIVES UNDERTAKEN BY BRICS NATIONS

In order to bridge the existing skill gap, several initiatives have been undertaken by BRICS nations. Though some initiatives have been undertaken at the federal / central level, a few nations amongst the BRICS have also entered into bilateral agreements with developed nations to further strengthen their efforts in skill development. Across the BRICS nations, expenditure on education as a share of GDP has increased over the years and has become a major part of country's total public expenditure, accounting for more than 10%.[13]

Brazil: Vocational infrastructure development

In Brazil, Sistema S, a group of 10 non-profit private institutes classified as autonomous social services, undertake activities related to public interest like skill development. Each of these 10 institutes is associated with a particular sector and is responsible for improving the quality of life of workers within that sector and providing technical and professional education to meet the industry demand of qualified workers. These institutes use funds raised by collecting mandatory payroll taxes from the firms in their associated sectors. The launch of a federal education and training program – PRONATEC – has also played a significant role in improving the VET quality and network, increasing educational opportunities from initial training to professional qualification and increasing pedagogical resources. Under the PRONATEC program, the Brazilian government has provided funds for establishing vocational institutes and has offered financial assistance (through scholarship and low interest loans) to students undergoing vocational education.[14]

Russia: Vocational skills promotion

Russia undertook the 'Skill Development for Industrial Growth' initiative under the Agency for Strategic Initiatives to bridge the gap between industry's skill demand and supply and to further strengthen academia-industry links. It has also taken measures like taking part in the World Skills competition to promote vocational education. Recognizing practical learning as an important aspect of vocational training, it has implemented dual education in 13 regions under this initiative.[15]

India: Vocational infrastructure and skills qualification framework development

In India, skill development was one of the most important points of discussion in the 12th five-year plan. As part of its National Policy on Skill Development, India has established the National Skill Development Corporation (NSDC) to support for-profit training institutes. Sector Skill Councils have been established to involve industry in certifying trainers and developing training curricula, occupational standards and qualification level competencies. India has also launched the National Skill Qualification Framework (NSQF) to provide mobility and has initiated the National Employability Enhancement Mission to promote the apprenticeship model of learning. The Skill India program has been launched to provide scholarships and low interest loans, to recognize prior learning, to give skill cards and certificates and to develop an apprenticeship portal. India has also collaborated with the European Union with the objective to improve quality and increase the number of skilled workers in various sectors.

China: Collaboration for dual training

In China, the government has started offering a subsidy of CNY 1500 (USD 230) per year to students in VET schools to offset their fees and has also launched an initiative to make tuition free for upper secondary vocational school students.[16] Additionally, Germany and China have been cooperating intensively in the fields of higher education and vocational education and training. As part of the collaboration, the Chinese Education Ministry and the German Federal Minister of Education and Research (BMBF) have been

holding regular strategy talks on education policy since 2004. They have also agreed to expand cooperation in the field of *Industry of the Future*, particularly in the context of smart production processes and joint research and innovation funding procedures.

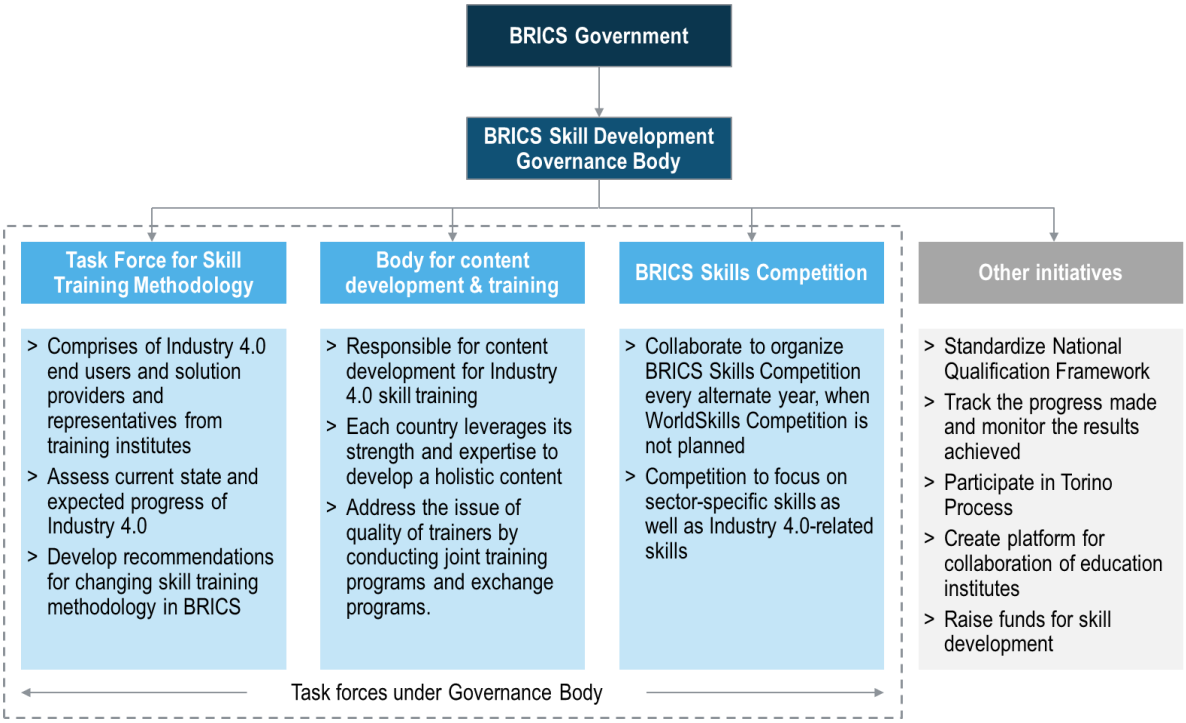
South Africa: Skill training body establishment

In South Africa, Sector Education and Training Authorities (SETA) were established as part of National Skill Development Strategy of 2000. SETAs have played an important role in expanding the vocational training network across the country. There are currently 21 SETAs, each representing a sector.[17] Each SETA is responsible for managing and creating internships, unit-based skilling programmes and apprenticeships within its industry. South Africa has also been levying a skill development tax of 1% on the wage bills of the companies for raising funds for skill development activities.[18]

3. RECOMMENDATIONS TO COLLABORATE FOR SKILL DEVELOPMENT

Though each of the BRICS nations has undertaken skill development initiatives, the current system of vocational education is not efficient to train the labor force for the factories of future. There exists an opportunity for BRICS nations to leverage their strengths to overcome challenges in skill development and to collaborate to make their labor force Industry 4.0-ready.

Figure 8 - Structure and functions of Skill Development Governance Body



1. Preparatory: Assessment of future skill demand

As part of the preparatory phase, a BRICS Skill Development Governance Body should be established with the collaboration of the various BRICS governments to oversee the skill development activities in BRICS nations.

A Task Force should be commissioned under the governance body, which should have representation from Industry 4.0 end users and solution providers and from the training institutes in each of these BRICS nations. This task force will be responsible for assessing the current state and expected progress of Industry 4.0 adoption. Based on the assessment, the task force will develop a set of recommendations revolving around the changes required in training curricula and methodology for meeting industry's skill demand at various stages of adoption of Industry 4.0. Their set of recommendations will then be passed on to the bodies involved in skill development in BRICS nations for implementing changes in the skill training methodology to ensure that Industry 4.0-related skills are imparted.

The governance body will oversee the functioning of the task force and will be responsible for coordinating with the skill development bodies for tracking the progress made and monitoring the results achieved with the implementation of recommendations given by the task force. It will be responsible for facilitating cross-sharing of learnings and challenges faced in skill development by BRICS countries. It will be entrusted with the responsibility to frequently assess and create a database of the strengths, competencies and weaknesses of BRICS nations in terms of skill sets. This database will be shared amongst BRICS nations and will act as a guidebook for collaboration opportunities.

As part of the preparatory phase, BRICS nations should also partner with European Training Foundation (ETF) and should actively take part in the Torino Process. The aim of the Torino Process is to provide a concise, documented analysis of vocational education and training reform in each ETF-member country, including identification of key policy trends, challenges, constraints, best practices and opportunities. The adoption of Industry 4.0 in the European Union and other ETF-member countries will increase focus on bringing elements of advanced technology in the skill development and vocational education system. BRICS nations can significantly benefit from actively taking part in Torino Process as it will help these nations to learn and adopt the initiatives and best practices followed by the other countries for skill development for Industry 4.0. Inputs received from participation in these processes will also help the governance body and the task force in creating recommendations that are in line with the international skill development activities.

2. Infrastructure: Improving quality of course content and trainers

In a number of BRICS nations, the curricula used for skill training are developed without the involvement of industry. As a result, the gap between skill sets demanded and skill sets supplied keeps on increasing. BRICS nations should involve industry in the skill development process as they play an important role in the job market. Efforts should also be made to involve Industry 4.0 solution providers in these councils as they can provide valuable inputs related to future technologies, based on which training curricula can be modified and improved further. Industry's involvement is also required to promote dual training / apprenticeships so that students are exposed to experiential learning and do not have only theoretical knowledge.

The BRICS nations can also collaborate to form a body, similar to SETA, and undertake skill training activities related to Industry 4.0 technologies like robotics, system integration, etc. by establishing training institutes across the BRICS nations.

The BRICS nations should set-up a body which will be responsible for content development for skill training related to Industry 4.0. Based on the skill sets identified by the task force and the sector specific skill councils, BRICS nations can collaborate together through the mentioned body for developing course content. This course content can be uploaded on a BRICS cloud (using digital technology) and shared across the nations. No one particular skill will be required for Industry 4.0. Workers will have to be trained in numerous skills to make them Industry 4.0-ready. And given that none of the BRICS nations are expert in all the technologies expected to form Industry 4.0, each of the BRICS nations should leverage their strengths and expertise to develop a holistic course content.

This body can also support in addressing the issue of quality of trainers available in the market. Just how each BRICS nation will use their expertise to develop course content, they can also collaborate to train the faculties or trainers. Exchange programs where trainers are exposed to industrial setups of other countries should be launched. Such collaboration would ensure that all the BRICS nations are able to benefit from the expertise of each other.

BRICS nations should also work together to set up a platform for collaboration of their institutes and universities. For example, TU Braunschweig (Germany) and BITS Pilani (India) are working together to set-up, at BITS Pilani, a learning factory which will consist of Industry 4.0 technologies. On similar lines, the skill

development institutes across the BRICS nations can collaborate to innovate and develop cost-effective learning tools related to Industry 4.0.

3. Implementation: Promote vocational education and increase its reach

Another important element of skill development is to efficiently provide skill training to the youth. BRICS nations face significant challenges in terms of the reach of skill development institutes (vocational training schools), which is indirectly related to the availability of funds. BRICS nations can collaborate and raise funds to support skill development initiatives. Alternatively, they can also raise funds from the New Development Bank (BRICS Bank) established to support infrastructure projects and can use these funds raised for establishing training institutes, which will help in increasing the reach of vocational training.

Initiatives like PRONATEC of Brazil have played an important role in promoting vocational education across the country. As part of the program, the government provides scholarships and loans for vocational education and funds for expansion of technical and vocational institutes. Other BRICS nations should launch similar program to promote and increase reach of vocational education. In line with the WorldSkills competition, the BRICS Governance Body can take the initiative to jointly organize a BRICS Skills competition for the five nations every alternate year, when the WorldSkills competition is not planned. The aim of the WorldSkills competition is to promote technical and vocational education amongst the citizens of its participating countries by raising the skilled professional worldwide. The World Skills competition focuses on all types of skills across the sectors. Similarly, the BRICS Skills competition can emphasize on basic sector-specific skills as well as Industry 4.0-related skills like mechatronics, data analytics etc. Such a competition will not only promote VET amongst the BRICS nations but also support skill development for Industry 4.0.

4. Opportunity: Standardization for increasing mobility within and across BRICS nations

National Qualification Framework (NQF) plays an important role in every country as it follows an outcome based approach and helps in defining the career progression track. If a worker has a particular level of certification, he or she can anytime go back and continue his or her education for the next level of qualification. All the BRICS nations except Brazil have their own national qualification framework, which provides workers with the mobility to shift education tracks from general to vocational education and vice versa. However, if a worker goes outside his or her country to other BRICS nations, he or she has to undergo certification programs again.

In order to provide easy mobility across the European Union (EU), the European countries have established a common European Qualification Framework (EQF), which acts as a translation device to make the national qualifications of European countries readable in other EU countries. Such a standard EQF facilitates mobility across EU and supports lifelong learning.

Similarly, BRICS nations can also collaborate to develop a standard qualification framework. Such a standard qualification will support a worker's mobility from one BRICS nation to another BRICS nation and, at the same time, will allow him or her to pursue education for the next level of qualification, avoiding any repetition. This will also help countries in standardizing the outcomes of learnings and occupational standards across the BRICS nations. As a result, the quality of workers joining the workforce will improve and the workers will have the option to move across BRICS nations easily. The qualification framework should also be modified to include elements of Industry 4.0 to ensure that a labor at particular level possess certain Industry 4.0-related skills, in addition to the technical skills he or she is expected to have based.on the industry demand.

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