HIGHER EDUCATION AND THE FUTURE WORKFORCE DEVELOPMENT IN INDIA

Dissertation

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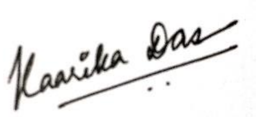
DECLARATION

This is to certify that the M.Phil. Dissertation being submitted by me on the topic entitled **'Higher Education and the Future Workforce Development in India'** has been completed under the guidance of **Prof. Mona Khare**. It is declared that the present study has not previously formed the basis for the award of any Degree, Diploma, Associateship or Fellowship to this or any other University.



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This is to certify that the M.Phil. dissertation entitled **'Higher Education and the Future Workforce Development in India'** is the work undertaken by **Ms. Kaarika Das** under my supervision and guidance as part of her M.Phil. degree in this Institute. To the best of my knowledge, this is the original work conducted by her and the dissertation may be sent for evaluation.

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Kaarika Das

Kaarika Das

Table of Contents

List of Tables

List of Figures

CHAPTER 1

INTRODUCTION

1.1 Background

According to Michael Porter (Porter, 1990), one of the prominent thinkers on competitive strategies for the growth of an economy, innovation is crucial in improving an economy's growth trajectory. Porter classifies the first stage of this development strategy as factor-driven, where the competitive advantage is based exclusively on endowments of labour and natural resources. The second stage as investment-driven where the efficiency of producing standard products and services becomes the dominant source of competitive advantage. The focus of such investment-driven economies is on manufacturing and outsourced service exports. The wages in this stage are higher, but these economies are susceptible to external sector-specific demand shocks. The third stage, innovation-driven, can produce innovative products and services at the global technology frontier using the most advanced methods, which becomes the dominant source of a nation's competitive advantage. The capacity to innovate and successfully introduce innovations in the market further enhances a region's competitiveness.

As an economy evolves from a factor-driven economy to an innovation-driven economy like the USA or Singapore, the use of technology and ICT becomes non-negotiable. The adoption of technology can be further expected to accelerate following the Covid19 scare because of the physical distancing imperatives imposed. Thus, India's future economic growth is contingent on the wise use and the wide diffusion of ICT across different industries (agriculture, manufacturing, and service). It can be safely anticipated that future industries would employ more intelligent machines, even in developing countries, following the trail of the developed country counterparts. As per UN estimates, two-third of all workers in the developing world could be replaced by automation(UNCTAD, 2016).

Emerging technologies such as Artificial Intelligence (AI), IoT, etc. are fast changes the nature of work, with emerging technologies increasingly invading the space of 'non-routine jobs requiring human interaction, facilitated by the improved sophistication of machines. Although change in work regimes facilitated by increased adoption of technologies is a continuing phenomenon throughout history, the new paradigm of change is qualitatively different. In the 19th century, the introduction of machines abolished the dirty and dangerous work carried out by humans and these jobs were taken over by machines. The 20th century witnessed the gradual wearing away of dull and monotonous jobs, which could be mostly clubbed under clerical chores. Finally, in the present 21st century, machines can make comparable decisions with automation, if not better, with more reliability, accuracy, and speed. Concomitantly the expectation from a country's workforce is changing. With large-scale digitization and emerging technologies, the existing job market condition is very dynamic – one that allows for greater mobility between occupations and industry throughout their career. However, literature establishes that automation will not terminate the demand for labour power. Nevertheless, experts caution that it will shift labour from one occupation to another. In such a backdrop, it is vital to prepare for such an anticipated demand of workers. Only through strategic preparedness of its workforce can India remain competitive in the highly volatile world order of the present times.

1.1.1 Role of Human Capital and R&D in Spurring Growth

The progression of growth theories is succinctly detailed here to capture the role of technology and human resource in augmenting economic growth. Revisiting economic history, the classical economists initially stated that output or income (Y) is a function of capital (K) and labour (L), i.e., Y= f(K, L). However, over time, the increase in labour and capital alone could not explain the rise in economic growth in its entirety. Then, Robert Solow, through his 'Solow Model,' explained that technological change enhanced and propelled the productivity and efficiency of both labour and capital(Solow, 1957). Technological innovation (denoted by T) was also included in the equation mentioned earlier, transforming it to Y= T*f(K, L).

However, Romer’s endogenous technological change growth theory deviated from Solow's economic growth theory (Romer, 1986). Solow's economic growth theory was based on the assumption of perfect competition, constant returns to scale, and the absence of externalities. As per Solow's model, technological change was assumed to be exogenous. Romer disputed this assumption and argued that technology was endogenous and a function of research and development (R&D) and human capital (HK), thereby claiming that T = f(R&D, HK). In a nutshell, this is how the R&D and Human capital came to be recognized as an integral component of technical innovation, leading to a country's economic growth. Since then, numerous empirical findings across geographical settings have long-established the significance of both these factors.

1.1.2 Workforce development (WfD) for building future growth capacity

As established in the previous section, growth theories have long argued that technology is a crucial driver of economic growth. What propels this technology-driven growth is human capital and innovation, spearheaded by R&D. The rationale for focusing on the workforce is that technology on its own cannot generate growth and, more importantly, sustain the high rate of output and improve upon it. To leverage technology, what is required is a skilled workforce (Tassey, 2017) that constitutes an economy's human capital. Human capital (in the context of future growth disproportionately fuelled by technology) would comprise skilled labour capable of using new hardware, software, and associated techniques. Especially in a digitally mediated world, focus on a country's labour force becomes a top priority.

Harris and Short, in their book on Workforce Development (Harris & Short, 2014), chronologically trace the development of the concept of Workforce Development (WfD). The authors distinguished it from employment training as WfD incorporates nature of employment demand, moving away from the traditionally focused supply-side skills. In earlier works of Harrison (Harrison & Weiss, 1998) he explained how WfD extended the notion beyond training. After a decade, the concept gained further popularity when policy dialogue in EU shifted away from skilling to WfD. The government of South Australia also started using the terminology WfD. Likewise, over time, international organizations have adopted the concept while strategizing for workforce capacity building. For instance, according to World Bank, WfD can be described as a strategy that help create, sustain, and retain a viable workforce. The objective of workforce development is to create economic prosperity for individuals, businesses, and communities. WfD focuses on an individual’s ability to grow their skills and develop the tools they need for business success. In other words, it trains individuals to be more productive and prosperous in the workplace, while benefitting both the employer and the worker (Tan et al., 2016).

The broad theme of workforce development deals with building human resources and compilation of practices that train and develop competencies of workers. It concerns developing and building people for being employable. However, the scope of WfD is often misunderstood and misrepresented as a title provided only to education and conduct training activities. Conceptually, it is a multifaceted terminology taking the 'systemic' approach. A host of factors are constituents of workforce development strategies such as education, training, support strategies for skills and knowledge like information systems, mentoring, discussion opportunities, research (Roche, 2001).

The three key reasons for using the terminology WfD are: firstly, it is a multifaceted and systemic approach that moves away from simply training/developing individuals to systems. Secondly, it is concerned more with the sustainability of the workforce vis-à-vis a quick fix that works for the short term. Thirdly, it takes into account the complex interplay of issues that affect the workforce and does not narrowly limit itself to analysing one dimension.

Altogether, there exists an impending need to shift away from the narrow confines of professionally developing workers at the individual level to a broad-based conception of workforce development. WfD provides scope for considering larger realms of improving workforce capacity above and beyond just highlighting skill gap and employability issues - which has become somewhat trite. However, a critical challenge in all WfD systems concerns ensuring a good match between skill demand and supply despite labour market conditions periodically altering and improvising the demand for skills. Nevertheless, its focus is not restricted to skilling and employability alone and equally incorporates other dimensions of capacity building, such as improving R&D potential.

Focus on WfD is vital for India because it aligns the labour market supply to the demand. Without adequate attention paid to WfD strategies, India's existing labor market will continue to deliver a poor match between skills demand and supply. Furthermore, in the (post)covid era, the risks posed by high unemployment and underemployment often coexists with chronic skills gaps faced by employers. As such, India's large pool of working-age population can only be capitalised on if the labour force is well endowed with relevant aptitude. The demographic dividend can only be an asset when this large population segment is employable, and workforce development succeeds in fruitfully engaging the labour force.

Thus, the 'Future Workforce Development' can be defined as the workforce/human resource/labour force/manpower prepared to undertake the challenges and uncertainty that comes with the future of work, in the backdrop of the ongoing changes brought about by technology. It puts human skills at the heart of competitiveness and growth.

1.1.3 Role of Higher Education (HE) in future workforce development

An economy's backbone is a productive labour force, one which India is in a unique position of leveraging because of the current bulge in demographic dividend.' However, a quality labour force is contingent on the skill, innovation, and education levels. It is worth noting here that the link connecting education and maximum optimization of technology is also supported by the empirical evidence that an inadequately educated workforce could not effectively take advantage of high technologies at all (Bucciarelli et al., 2010). Higher education offers distinct advantages through its focus on the importance of education, skills, work, and building the innovative capacity of students (Kruss et al., 2015). In India's case, the best indicator for assessing human capital development is through the higher education sector (Pai, 2019).

Higher education feeds directly into fostering technology-led growth as it improves the workforce's skill level and also advances R&D as well as innovation. On the one hand, appropriately trained skilled personnel can improve the business efficiency of industries and enhance productivity. On the other, superior quality independent research activities spur significant and timely innovation, better policymaking, and empowers transition to an innovation-driven economy.

Moving away from growth to competitiveness, one of the critical determinants of competitiveness is Human Development and effective public institutions. The relevance of higher education in improving an economy's competitiveness is evident from the fact that higher education constitutes one of the twelve pillars based on which the global competitiveness rank of a country is determined.

However, Indian higher education has numerous issues plaguing it. It is not just the uneducated and untrained who lie below the required standard (in terms of skills) but even those with higher education credentials (Khare, 2014). On the one hand, higher education enrolment has increased four-fold since 2001, with a Gross Enrolment Ratio (GER) of higher education at 26.3% in 2018-19 as per AISHE (MHRD, 2019). However, the graduates' quality and employability are deplorable. Graduates of three-year programs find it difficult to enter the organized sector as Higher Educational Institutes (HEIs) seldom impart skills that are readily relevant to the job market (Ravi et al., 2019). There exist a witnessed mismatch between skills/education and jobs/occupations. Overall, there is a general consensus that India has a low base of globally accepted Work-Skills benchmark (Khare, 2016). This variation can also be attributed to the heterogeneity existing within the higher educational institutes. The only silver lining in the cloud is that employers demand highly educated and formally trained workers, especially in the services sector (Khare, 2015). Presently, higher education has become a precondition for recruitment.

A case in point is the US educational system that produced superior skilled workers and, therefore, were the de facto world leaders spearheading the digital revolution. In countries like the United States, China, and South Korea, research universities drive institutions of the 21st-century knowledge economies (Ravi et al., 2019). In contrast, India lacks a culture of independent academic research, baring a few research institutes. Moreover, the research produced by Indian HEIs also lacks quality, with low and declining standards (Ravi et al., 2019) (Agarwal, 2008) (Sharma & Sharma, 2015).

1.2 Methodology, focus and scope of the study

The thesis problem statement is that there exists significant ambiguity in concretely assessing higher education's role and success in catering to the demands of the emerging workforce requirements, in the backdrop of existing undercurrents such as the fourth industrial revolution, covid etc. Such undercurrents of change leading to an upshoot of freelance work, automation etc. is highly likely to displace white collar jobs as easily as it continues to displace blue-collared jobs. The paper will briefly touch upon such future work drivers and consequently emerging changes in the job profile owing to these trends. Although such trends should not be distressing since general concern over technology replacing jobs dates back to the Luddite movement of the eighteenth century. However, what warrants attention is the how higher education is placed to provide for the changes ushered by Industry 4.0 and beyond, as higher education has direct bearing on workforce effectiveness and productivity. Without devaluing the importance of 'skilling' as conceptualized by vocational training, the focus has been deliberately narrowed to higher education, excluding the contribution of non-formal and vocational training. Notwithstanding the normative value of education, the scope of this study is limited to understating how well higher education is tailored to meet the demands of labour market which supports an innovation driven economy.

Thus, the paper's focus is on the interactive space of higher education, growth, and labour market. In analysing the dynamics among these parameters, it attempts to answer how uniquely positioned India's Higher Education Institutes (HEIs) are in aiding the future workforce development of the economy. Despite the fact that growth can and is propelled by numerous value additional activities, the scope of the paper is to concentrate only on the knowledge economy aspect and growth triggered by the Industrial Revolution 4.0. Furthermore, to holistically understand the all-India situation, the paper undertakes a macro-level analysis by aggregating the performance of different states. The investigation is restricted to the Indian states only and union territories have been deliberately excluded because of inadequate data. The period for which the indicators are incorporated and analysed is between 2017 to 2020.

1.3 Significance of the Research

The youth of today make up the workforce of tomorrow. However, quality labour force is contingent on skill and education levels. Recent trends indicate that both the labour market and the HEIs have become more segmented. While the labour market has become more flexible and limited (jobless growth), the HE systems have become more specialized and costly, thereby generating greater concerns over the value and returns to a college or university degree. Higher education's need and relevance in such a backdrop is worth scrutinizing as it has a direct bearing on the workforce. Such analysis will enable in aiding HEIs to evolve in tandem with the changes ushered by Industry 4.0 to equip the workforce with the necessary know-how of the future.

While there have been researches on HE and its impact on growth and labour markets, none has specifically focused on how well HEIs of different Indian states are equipped to produce graduates who have the necessary competencies. The rise of reports released periodically by the corporates on the skill gap prevalent in the labour market suggests that policymakers, industries, and youth are highly aware of the issue at stake. However, it remains unclear how adeptly higher education responds to the following changes brought forth by emerging technologies in workspaces. To fully understand how HE can enhance economic growth and drive competitiveness by aiding in workforce development, it is essential to gain a holistic yet nuanced view of the complex relationship imbibed within the interactive space of education-workforce-growth.

This research proposes a novel way to re-look at the existing scenario in the interactive space of India’s growth and competitiveness, higher education and workforce. Several pieces of research have delved into higher education and growth, workforce and higher education, and growth and workforce. However, such researches have been primarily done in isolation examining the interaction of these components in silos, the present paper aims to zoom out and provide an overarching perspective.

Parallelly, to avoid falling into a one size fit all prescriptive trap, the paper also provides insights on the regional variations. Such inter-state variation in Higher Education and its corresponding relation with economic growth remains largely unexplored, despite its impending need. This exploratory study will help provide an overview of the country's workforce's potential in ushering and sustaining the paradigm of knowledge-based economies. The findings will have bearings on how best the HEIs can be developed and supported to enable WfD in the path of high-quality, technology-led growth and employment.

1.4 Research questions

I. How well is India’s HE sector aligned to support and meet future workforce requirements?

II. What is the existing inter-state variation in meeting future workforce requirements?

III. How closely are growth and competitiveness related to higher education mediated workforce development in the different Indian states?

1.5 Research objectives

I. To assess how far the Indian Higher Education (HE) system is equipped to address the educational needs arising from future growth drivers.

II. To develop an index that shows future workforce potential arising from higher education

III. To compare regional and inter-state variation in workforce potential, based on the constructed index.

IV. To analyse the relation between future Workforce Development (WfD) potential of states, enabled by higher education and growth across different Indian states.

V. To determine the association between the competitiveness of Indian states and the future workforce development mediated by higher education.

1.6 Research Design

This study relies heavily on quantitative methods. It employs exhaustive analysis of the available secondary database on aspects of higher education which propel future workforce development. Using these data points, a composite index is created. The rationale for adopting a composite index (CI) is primarily owing to its ability to encapsulate complex and multidimensional data points into a single-point value, which is easily comparable. This ensures that not only policymakers and academicians with special training, but even the general public and other stakeholders without any specialised knowledge can gain a comprehensive understanding about the issue. This is because CIs scores being single point estimate are easy to interpret and enables benchmarking. Furthermore, CIs also makes it possible to gauge progress over time by just updating the indicator points whenever the latest version of data arrives.

In this paper, the CI has been utilized to get an all-inclusive account of relevant state-level indicators. This has been enabled in the thorough examination of existing regional disparities. Finally, state wise the CI has been juxtaposed with growth and competitiveness ranking for uncovering the underlying relation between the indicators.

1.7 Overview of the study

The structure of the thesis attempts to adopt a narrative style approach, which starts with the first chapter detailing the future workforce drivers and anticipated workforce trends. The second chapter looks at the state of higher education in meeting the anticipated workforce trends of the future. It also creates a framework of reference for skills required in the digital economy and underscores the role of HE researches as a driving force of economic growth. Based on the literature and theories analysed in Chapter 2 and Chapter 3, the second chapter calls to attention the research existing research gap and further builds the conceptual framework of the study. Chapter 4 delves deeper into the methodological aspect of the study – the rationale, motivation, step-by-step guide and indicators used in the construction of the composite index – Higher Education Future Workforce (HEFW). It also elaborates on the methodological decisions taking for aggregating and deciding the weightage of each indicator of the index. Chapter 5 presents the results of the index and exhibits the state-wise and regional performance in higher education's ability in meeting future workforce requirements. Chapter 6 establishes linkage between the HEFW potential with economic growth and competitiveness respectively, while checking the validity of the constructed index. Finally, Chapter 7 concludes by summarizing the thesis, highlighting limitations and recommending policy measures.

CHAPTER 2

FUTURE WORKFORCE – DRIVERS AND TRENDS

The feedback loop between emerging technologies, jobs, educational institutes and economic growth is fairly complex. In order to untangle this complex web, the literature review touches upon each sub-aspect of the cycle - the future growth drivers, the transpiring employment trends and the role of higher education. The starting point of the Literature Review is a comprehensive analysis of the determinants which drive future growth. Such factors consequently influence the way a society works, learns, live etc. The first part delves into identification of such emerging technologies, how they fundamentally change how things operate and consequently how they impact the evolving nature of work and highlights the resultant emerging trends of employment arising from those. The second section analyses literature in the intersection of higher education and workforce development. Finally, the third section draws on the research gap from the first preceding two parts and arrives at a conceptual framework of the study.

2.1 Drivers of change shaping future workforce requirement

2.1.1 Introduction

To prepare a workforce suited for undertaking future job roles, it is vital first to understand the factors that influence or shape the future world of work. Without discounting the uncertainty that remains about a society's development pathway, it goes uncontested that technological advancements will drive a sizeable number of employment trends. History is an alibi to this fact, as an overhaul of the labour market accompanies each new epoch of scientific development to suit its specific demands. The Fourth Industrial Revolution (IR 4.0), being the anchor of the present epoch, is triggering a lopsided influence on how the world of work is reorganized to suit its requirements. However, to attribute all the changes to IR 4.0 alone would be grossly reductive, as the broader socio-economic, geopolitical and demographic also exert significant influence on the world of work. This chapter attempts to uncover such driving forces and trends of future work to extrapolate and assess the skillset needed for preparing the future workforce development strategies.

2.1.2 Drivers of change

2.1.2.1 IR 4.0

Industry 4.0 is a term used to imply a new paradigm of technological advancement which is unleashes significant changes in how the industry functions. The technological advancement of IR 4.0 has significant bearings on improving resource and time efficiency, while modifying the way people work. As such, IR 4.0 is an aggregate set of emerging technologies whose deployment is presently underway but the full potentially continues to be unrealized. To better understand the exact constituents of the fourth industrial revolution, here are the key technologies driving IR 4.0 which enable the creation of new business models -

A. 5G

The fifth generation of mobile communications is popularly known as 5G. Launched in the first quarter of 2019, this cellular network is the successor to the 4G network, which currently provides connectivity to most cell phones worldwide. Awaited to replace 4G, the primary advantage of 5G is its speed, bandwidth, and latency. which will lead to faster download speeds. Because of its expected bandwidth, its service will no longer be restricted to cell phones and cellular networks and as a general internet service provider such as cable internet connection (which are significantly faster as fibre optic cables help transmit high-speed data). Given its broad scope, its possible impact will lead to a spur in IoT and Machine learning.

Although each generation of cellular networks has improved from its predecessor, 5G is a massive leap in terms of applicability, advantages and bandwidth. The usage of 5G can be broadly sub-classified as a Mission Critical Services (MSC). MCS are those services whose disruption would lead to the halting of an entire business or operation. As a highly reliable wireless support, 5G enables the operation of autonomous vehicles, drones, industrial automation etc. It will also drive value chain creation in the larger economy. This is because the network can be used for numerous other devices (such as office buildings, industrial parks etc.) as high magnitudes of data can be facilitated by lower cost of data transmission. IoT (Internet of Things) uptake would also increase considerably, with larger amount of mobile used to address IoT applications

Thus, the arrival of 5G is a tipping point for the progression of mobile from a personal technology to a General-Purpose Technology (GPT)[1], as it will affect practically every industrial sector, with its integration and adoption across various industrial sectors already in line. Such diffusion of technology will foster improved usage of the network across various industries like banking, transport & logistics, agriculture, forestry, media etc (Prasad & Aithal, 2015) (WEF, 2020).This will also have a cascading effect whereby socioeconomic benefits accrued through higher productivity and improved economies of scale will translate into better standards of living.

Thus, it is not surprising that as per study by IHS Markit, by 2035 5G can potentially stimulate $ 12.3 trillion in global sales across different value chains, while generating $3.5 trillion in output and supporting 22 million jobs(Campbell et al., 2017). Numerous studies have corroborated that 5G will spur business innovation and foster economic growth and consequently, leave a lasting impact on the job market.

B. Big Data

Each second humungous amount of data is generated with each click, google search, transaction record, tweet, image etc. this astronomical magnitude of data is huge reservoir of information to the extent that in recent past, the saying 'data is the new gold' has become somewhat of an adage. The growth of Big Data can in large parts be attributed to the explosion of storage capacity, mediated largely by cloud technology.

Consequently, the job profile which has witnessed a surge is that of a data scientist. The competencies of a data scientist include being able to extract and interpret rich web data and process it to actionable insight. The abundance of data has led to data scientist being termed as the 'engineer of the future'. However, the skill set of a data scientist span multiple subject area and is not limited to computer science graduates only (Mikalef et al., 2018). (i) data generation, (ii) data acquisition, (iii) data storage, (iv) advanced data analytics, (v) data visualization, and (vi) decision-making for value-creation.

[1] GPT are the CATALYST for morphing how work is undertaken and even how economies are structured or operate. The classic example would be that of electricity. A greater wave of economic activity can be witnessed once the network infrastructure improves the way of conducting economic activity.

C. IoT

It refers to the objects (or things) which can communicate with each other, using wireless and cloud technology about functionalities. Such objects can also communicate with people. This coordinated communication between physical and computational elements has severe consequences in shaping the future society. In a world where machines can interact among themselves and humans with equal agility (if not more) of humans, one can instinctively deduce that this ability of machines to mimic several 'human' functions can not only improve the functionality of equipment but also make such machines capable enough to displace certain human mediated occupations. The application of IoT device ranges from consumer to industrial to infrastructural.

As per a research study estimating the economic impact of IoT on Total Factor Productivity based on data from recent past, the economic growth potential is tremendous, especially at this nascent stage of diffusion. The contribution to economic growth largely stems from the network effect (such as impact on big data creation, ML, improving allied industries etc.) which is four times as much than the direct capital contribution made by IoT itself (Edquist et al., 2021). Thus, IoT is one of the key drivers of the future economy with direct influence on future work.

D. AI & Machine Learning & Robotics

AI is a blanket term involving deep learning, natural language processing, natural language generation etc. Presently, at the helm of emerging technologies, Artificial Intelligence is spearheading the changes. The government in recognition of the importance of AI has also launched the National Strategy for AI. AI in essence, is the fundamental principle of building and designing machines capable of thinking like humans so that machines can carry out tasks 'smartly.' Subclassified as generalized and applied AI. The former deals with equipping machines with intelligence to turn them into systems capable of replicating human intelligence. The latter, applied AI deals with solving specific tasks, simulating human thought.

Machine learning is a subset of AI using deep learning strategies. It is premised on the idea that machines can learn for themselves if they are fed with sufficient data on the subject matter. Instead of teaching computers everything they need to know, ML teaches machines how to learn for themselves. ML advancement has witnessed a surge following the internet revolution, which has exponentially increased digital information. This data (popularly known as Big Data, explained previously) generated each day through online interactions is utilized for training ML. So, machines are technically coded to think like human beings by plugging them into the Internet- by some designed neural network designed to mimic human decision making. Based on the system's data, the machine makes decisions, predictions, and statements by analyzing the probability. An attached feedback loop enables precision where the machine is made aware of its decision, statement, or analysis accuracy.

Given its ‘self-learning’ capabilities, it is undisputed that AI and automation have a severe consequence of disrupting labour. This transition, however, is not linear insofar as machines taking over all human labour. Nevertheless, work undertaken by low-skilled manual workers will be taken over. E.g., in the legal field, AI is used to scan thousands of documents to bring out points relevant to the case at hand. In medicine, AI is used to scan X-ray to assess any signs of disease- thereby improving diagnosis. So, although an occupation in its entirety is unlikely to be wiped out. Instead, the monotonous and repetitive part of the job will be taken up by the machines. The AI phenomenon is not limited to service sector alone as it is set to bring forth change in agribusiness landscape as well. For instance, an increase in the impact of automation and digital supply chain management has severe impact on agricultural production, processing and trade – extending beyond the urban economy and covering the rural economy under its ambit. Parallelly, automation is also predicted to improve efficiency by reducing human errors - this in turn, has positive implication for enhancing productivity.

2.1.2.2 Digital Platforms

Digital platform is a place for exchanges of information, service and goods which occur between producers and consumers. The product is not the platform but a cumulation of services, applications and solutions on the ‘platform’ where the customer interacts and gets paid for. Effectively, it is a virtual market which facilitates transaction between businesses, between customers, and between businesses and customers. Examples include Facebook, Google, Amazon, Uber etc. The rise of e-commerce platforms is a clear indication of the popularity of platforms. The rise of platform economy is because of how using technology it lowers the transaction cost.

It is worth noting that platforms are not just an efficient aggregator of information but has huge job displacing ramifications. For instance, in case of a platform like Amazon, it entails increased requirement for warehouses and workers engaged therein, with an accompanying decrease in retail stores. Different new forms of work have consequently emerged and most popular among them is the on-demand work through platforms. Numerous dimensions of employment relationship are also consequently impacted such as – what constitutes the workplace, how wages are determined (piece rate instead of salary), measurement and meaning of work time etc. Thus, in case of platform economy, it is the power of internet which frames and shapes the economic lives of many. Because they frame marketplace interactions, they have greater leverage to influence market structure and consequently, the economy(Kenney & Zysman, 2019). For instance, for designing and maintaining the platform infrastructure, more workforce with STEM capacity might be required. Majorly, however, the workforce requirement of highly skilled professionals is narrow for now and as such, digital platforms perfectly depict the hypothesis of 'skill biased technology change' (expanded in next section) in reality. A brief overview of Table 2.2 shows how most of the 'high value-high paying' work in a slim proportion concentrated as a sub-segment of Segment A (Venture labour who are full time employees of the Platform Firm) and Segment C (Creative talent and Entrepreneurs who create media for Platforms). With India witnessing an enormous surge in e-commerce companies (a digital platform), the displacing and morphing role it brings about in the labour market is worth taking note of.

Table 2. 1- Workforce Distribution in a Platform

Segment A	PLATFORM FIRM	VENTURE LABOUR (Full time employees) - Creating and maintaining platforms CONTRACTORS (Not employees) - Servicing platform as per requirement basis - Salary by the job - Routinized work
Segment B	PLATFORM MEDIATED WORK	PLATFORM PARTNERS OR WORKERS (Contractual) - Such as delivering personnel, platform drivers - Salary by the job

		- Direct work
Segment C	PLATFORM MEDIATED CONTENT CREATION	CONSIGNMENT CONTENT CREATORS (Self-employed, freelance, entrepreneurs) - Income from sales and advertising - Includes creative content creators NON-PLATFORM ORGANISING CONTENT - E.g. include website creation, maintenance USER GENERATED CONTENT - It is the data produced by users (while interacting in Platforms) from which value is extracted - Not employed or paid

Source - (Poutanen et al., 2019)

2.1.2.3 Clean Energy

Concerns of environment and climate change, although existed for long, it is only in the past decade that policy priorities are implementing measures to remedy climate crisis. A report from the Intergovernmental Panel on Climate Change (IPCC) highlights how there is a gradual shift towards harnessing renewable energy power, alternately called Clean Energy would mark the upcoming decades(Tollefson, 2011). This has been proven true with the deployment of renewables reaching record levels – in terms of GDP contribution, capacity addition, infrastructure improvement etc. As reducing greenhouse gas assumes a key national concern with solar energy taking the centre-stage in India, the workforce requirement for this niche sector has experienced a witnessed uptake worldwide. With ever-increasing investment channelled into renewable energy, experts suggest that the trend is here to stay and ‘Clean jobs’ will be a significant part of the workforce demanded in the future – both by contributing to direct employment as well as indirect jobs. There is a net positive employment with the expansion of clean energy, as has been empirically tested for European countries like Germany (Lehr et al., 2012). Even in case of the US, a statistically significant impact on green jobs was realised (Yi, 2013). Surprisingly, even in middle-eastern countries which benefit the most from the production of non-renewable energy, stands to benefit from clean energy in terms of jobs created (van der Zwaan et al., 2013). This increased employment footprint of clean energy jobs is not limited to developed countries only. Even in under-developed and developing countries like Africa this is true (Shirley et al., 2019). However, the transition will entail loss of existing jobs, some of which are easier to replace but not all. These studies also reveal how clean energy jobs require training, upskilling and relocation.

2.1.2.4 Covid 19 Pandemic

Although the short-term consequence of the pandemic was severe with a spike in cases of workers furloughed, there are many trends in the post-pandemic economy which is here to stay. As per McKinsey, the pandemic accelerated the existing trends of remote work, e-commerce and automation with up to an increase of over 25% more workers absorption, than previously estimated(Lund et al., 2021). The jobs which necessitate the requirement of a high physical proximity is the worst affected such as frontline workers, personal care professionals, onsite customer interaction, travel and leisure etc. These jobs are more likely to undergo long-term disruption and transition. Meanwhile occupations requiring little or no physical proximity are least likely to be impacted. This gives immense leverage to those professionals who are adept at working from home or remotely. However, remote work often necessitates familiarity with technology, software etc and perhaps more importantly, an uncompromised willingness to learn. Thus, Covid 19 has succeeded in accelerating the pace of new work regimes fostered by the spike in technology adoption.

2.1.2.5 Others

There are numerous other demographic and socio-economic drivers of change ranging from the rising middle-class in emerging markets to the geopolitical volatility to concerns about ethical and privacy issues. Moreover, there are additional ‘black swan’ events which are unanticipated events such as the Covid-19 pandemic. Such factors cannot be listed and consequently, have little bearing on preparing for workforce development as these trends cannot be forecasted.

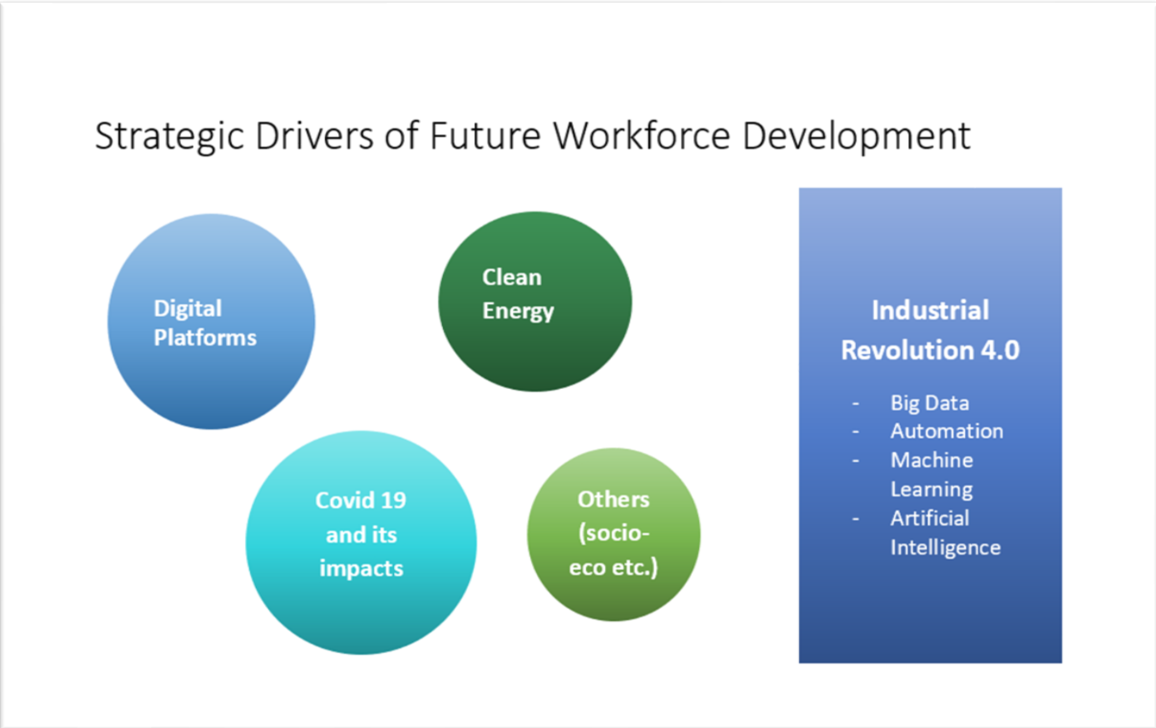

Fig. 2. 1-Strategic Drivers of Future Workforce Development

2.1.3 Emerging workforce trends

The existing form of employer-employee model in the labour market is a relatively new phenomenon ushered by the industrial revolution. Previous successful models included the guild system comprising of masters and apprentices. And historically, new forms of work and disruption in a given employment regime is brought about by development and advancement of new technologies. Even in India, the IR 3.0 had significantly raised the share of workforce in the service sector. Thus, based on the literature reviewed, the changing formation of the labour market can be broadly condensed in the following trends:

2.1.3.1 Gig Work – a new model of employment

Gig work are freelance workers or independent workers employed temporarily by organisations. Workers enter into an official arrangement whereby the gig workers provide service for the organisation's clients. As such it constitutes of three major component – firstly, a project or work to be completed; secondly, a client requesting the work and finally an organisation which connects both (Istrate & Jonathan, 2017). For instance, in case of UBER or Urban Clap, the workers or drivers providing services is the work to be done. The consumer is the client requesting the job and finally the company connects both. In US and EU, close to 20-30% of the workforce is engaged in gig work directly or indirectly (Lund et al., 2021). In India, based on estimates of Boston Consultancy Group, gig work has the potential to add up to 90 million jobs in India's non-farm economy, while adding upto 1.25% to the country's GDP(Augustinraj, 2021). While the opportunity that abounds gig work is the scope it endows to workers to supplement income, there is a greater ambiguity whether such workers can be considered employed or self-employed. Gig work per se is not a novel concept for the Indian workforce where millions are engaged in 'casual work' segment under informal work arrangements. However, fundamentally different when people talk about gig economy now, is the technology mediated and enabled types of work (Istrate & Jonathan, 2017) driven by an increased entrepreneurial spirit. While other authors content that there is barely anything novel as far as employment and gig work is mostly a rebranding of an existing form of precarious work (Sargeant, 2017) propelled by the concerns of businesses to cut costs and reduce risk arising from unfair dismissal (Friedman, 2014). Notwithstanding the debate surrounding it, the key takeaway is that gig-work is here to stay and the requirements of these roles is mostly concentrated in unskilled jobs, semi-skilled and low skilled jobs. Despite the low skill requirement, entrepreneurial spirit is vital to thrive in a gig economy.

2.1.3.2 The Rise in Automation and change in conventional value chains across sectors (primary, secondary and tertiary)

As per UN estimates, two third of all workers in developing world could be replaced by automation (UNCTAD, 2016). As per a McKinsey study, 45% of the existing work which individuals are paid to perform will be automated in the US. This includes automation of activities and the reformulation of job and business processes. Automation of tasks would be spread across the industries as well as across the hierarchy of occupations, including parts of the existing highly paying jobs. The hourly wage rate is not the predictor of automatability rather a machine's ability in successfully replicating the sub-tasks of a work profile is the most telling indicator (Chui et al., 2015). Applying machine learning and predictive data analysis enables quicker decision making – thereby implying it is not just the repetitive tasks which are being substituted by technology (Khairawati, 2020).

In service sector such as the retail space one can already see robots and IoT offering connected stores, RFID tags, inventory computing being automated by computing. Even in the agricultural sector, modification of conventional value chains such as robotics and automation impact agricultural production. Automation will especially have far reaching consequence for developing countries, as agriculture is labour intensive there. It will also severely impact manufacturing sector by hollowing out the workforce. This trend is already underway Thus, impact of automation will profoundly disrupt the value-chains across the sector complex ways.

The probability, intensity and pace of work being automated has been further accelerated by the Covid 19 pandemic with increased utilization of robotics and automation of warehouses, grocery stores, manufacturing centres etc (Lund et al., 2021).

2.1.3.3 Skill Biased Technological Change

The phenomenon of Skill Biased Technology Change (SBTC) is the prime mover of the witnessed changes in the labour market requirements overtime. The hypothesis contends that technological change leads to wage inequality by bringing forth polarization of labour market – both in terms of wages and employment scope. On one end of the spectrum there are highly skilled well paid worker while at the other accommodates low skilled poorly paid workers (Autor et al., 2003). The rise for the demand of both low-skilled workforce and high skilled workforce happens concomitantly (Autor & Dorn, 2013). The only caveat being, as was the case historically, the relative demand favours college graduates (Autor et al., 1998), thereby revealing a bias towards highly skilled workforce. This tendency, although well documented for the US, also has empirical evidence supporting it for the Indian scenario(Berman et al., 2005) (Unni, 2004). Some authors refer to the conceptualisation of Race between Education and Technology (RBET) which is an analysis of the co-evolution of wages and education leading to the finding that the three components – wage, education and technology are involved in a sort of race, which has led to rising inequality. It contends that technological change pushes the relative demand for workers who are educated, leading to a situation of rising wage inequality as the supply of skilled workers takes time to catch up. The secular growth for educated workforce is a compelling reason for increased investment in the Higher Education segment.

2.1.3.4 The Rise of Remote Work

Matthew Clancy(Clancy, 2020) argues that the rise of gig work or tele-work will increase in greater magnitude owing to four major reasons – firstly, the productivity of workers switching to remote work is comparable or higher than those working alongside in a physical space or an office. Secondly, remote work opens the employability pool of the employers who can employ global workers with the right skill set. Thirdly, they also tend to be cheaper as the workers generally prefer flexibility and the establishment cost of the industry is further reduced. Finally, the benefits of positive spill over while working work together is retained to a considerable extent as majority of the scope of such work is knowledge work. Barsness, Diekmann and Seidel (Barsness et al., 2005) however noticed mixed effects of remote working on performance. Given that this study was conducted in 2005, it is safe to presume that the level of advancement of technologies was not near its potential as it is today and so that needs to be discounted from the study as well. Rudnicka et al. (Rudnicka et al., 2020) establishes how the attitudes towards remote work was mixed and uneven before the Covid 19 pandemic and there was a widespread suspicion about teleworking and often discounting it as an inferior type of work vis-a-vis proper regular work. This germinates from the accompanying difficulty in transitioning to work from home such as lack of equipment, getting acquainted with remote meetings and the blurring of boundaries between work and personal life. These causes of inertia were broken down with work from home coerced on individuals during the pandemic. Thus, studies now ascertain that remote work will be persistent and in fact rise even post the pandemic. Reports

(McKinsey, 2020) also warn that most work roles which have to be mandatorily conducted on a given location, such as using a specialized machinery for city scan, are largely low wage work and thereby increase the likelihood of deepening inequalities.

2.1.3.5 Concentration of job roles in STEM (including creative roles)

With the erosion of traditional form of employment, there is a concomitant rise in the personnel requirement of people with STEM skills (Bennett et al., 2020) as well those with creativity. These two dimensions are especially critical for availing meaningful work. The importance of STEM jobs is not just in STEM fields but equally as much in non-stem fields, although these jobs may not be explicitly posted as STEM jobs (Grinis, 2019). Even the much heralded O*NET (Occupational Information Network) information on skill requirement (one of the most widely acclaimed study on skilling) reveals a clear-cut bias towards skill set involving intensive STEM knowledge in navigating production complexity (Lo Turco & Maggioni, 2020). The rationale for the rise in creative jobs arise because machines are not competent to carry out task requiring creativity and high level of dexterity and emotional intelligence. Even in STEM fields, the ability to creatively employ technology is a sought after skill-set by employers. Creativity, sensing emotions alongside ingenuity are strongly rewarded and constitute a significant proportion of the high-value future jobs (Schmidt et al., 2016).

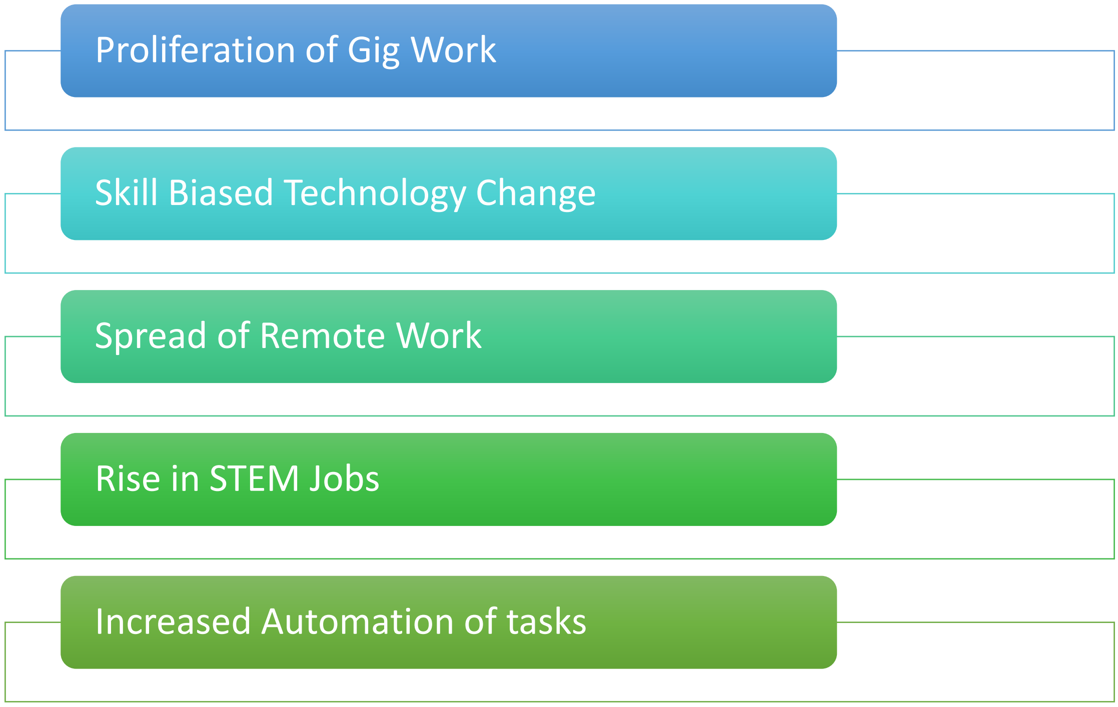

Fig. 2. 2- Emerging Workforce Trends – A Summary

2.1.4 Implication of upcoming trends on future WfD

Overall, the drivers of future workforce are myriad, yet IR 4.0 is set to have a disproportional impact as established above. While costing jobs in certain sectors like manufacturing, it is also positioned to create new genres of employment with changing business models as well as working conditions.

Literature also confirms exacerbated polarisation in the labour force. Thus, broadly the proclivity of the job market in the near future to offer 'high value though-based professionals' alongside jobs without the requirement of specific skill sets will exacerbate the existing disparity in the labour-force – a tendency captured by the SBTC hypothesis. Mostly notably, the latter will be felt in job profiles which can be easily automated. The most seminal work in the field conducted by Autor establishes that the increased use of technology has a polarizing impact whereby the proportion of workers in the low education and low wage occupation increases alongside high skilled work. These polarising tendency leads to the gradual elimination of middle skill jobs. Those engaged in low-skilled-low wage job for the sake of survival, might have to continue working under oppressive work relation while the high skill employees are likely to reap the dividend of a workspace characterized by greater trust and transparency (Lund et al., 2021). Moreover, a rise of independent employees with flexible working regime has the potential to normalise gig work as well.

The implication of increased adoption of technologies, automation, gig work is profound for education system as well as addressing the future workforce skill requirement. As has been emphasized above, the requirement for lifelong learning, reskilling and upskilling is indispensable for availing high paying jobs. The jobs which are complementary to automation (instead of substituting) are the ones with higher wages. The future trends are favourable for high skilled work profiles as digital technologies further boost the productivity of highly skilled workers in selective sectors. Such work can be broadly categorised as some form of knowledge work. For the workers to be efficiently employed in the knowledge work, whose demand for workers has witnessed a secular increase, the skill content of the jobs need to be the centre of the focus. The changing skill content can be a boon for reaping India's demographic dividend many workers outside this 'new economy'. Thus, the workforce development strategy should prioritize training workers in accordance with the changing dynamic of sought-after jobs. In such a backdrop, education as one of the key supply side-factor of workforce development, needs to be revisited.

CHAPTER 3

HIGHER EDUCATION AND FUTURE WORKFORCE DEVELOPMENT

3.1 Higher Education’s contribution to an economy

Although the importance of primary and secondary education is far-reaching, it is ultimately the state of HE system which differentiates dynamic economy from a marginalized one (Agarwal, 2008). India is a testimony to this phenomenon, as skill and knowledge have spurred economic growth in the country by contributing to the service sector. Moreover, in India it has already been shown that there exists a direct correlation between per capita GDP of a country and GER in higher education (Prakash, 2007). Not just economic growth, there are other indirect ways by which HE contributed to the economic development such as improved earning, reduction in relative and absolute poverty, gender parity, life expectancy, and improvement in other human development indicators (Tilak, 2010).

Presenting a growth model, Nelson and Phelps argue that people with higher education impact growth in two ways – firstly, through their improved efficiency in pursuing regular activities compared to other workers. Secondly, their increased competence in making the most of new technological opportunities presented in the economy. The marginal productivity of highly educated gets reflected in the rate of technological change. To back their theory, the authors show how highly educated farmers were the first to incorporate new technologies, which led to improved yield (Nelson & Phelps, 1966).

In Schultz’s 1975 paper titled “The Value of the Ability to Deal with Disequilibria”, Nelson and Phelp’s analogy of farmers was tested in India. The result was similar, with educated farmers being more productive compared to the average performance of regions where green revolution was underway. Deriving from this discussion, Schultz makes the case that educated workers are better prepared to ‘deal with disequilibria’ (Schultz, 1975). This ability can be interpreted as the ability to navigate uncertainty, or as per Schultz, it is the ‘entrepreneurial’ ability. He further extrapolates that ‘stationary economies’ (which rarely are invested in technological development) are closer to the equilibrium condition compared to dynamic ones. Such an ability is a crucial 21st century skills, with uncertainty being a norm than an exception.

The other reason how higher education contributes to economic growth is through an indirect route. Indirectly, higher education drives ‘innovation-driven’ growth compared to ‘factor-driven’ economies, thereby improving the competitiveness of an economy. This is aligned with the investigation of Lorenz and Valery. They undertook an analysis using logit regression, controlling for differences in sectors, occupation, size of institutions etc., while calculating the impact of a nation on grouping work organizations reveal that income level has a bearing on the type of work organization in the economy. Their results revealed how poorer countries had a significant chunk of their workforce in Taylorist organizations while in richer countries, a larger proportion of workforce engaged with workplaces where discretionary learning takes place (Lorenz & Valeyre, 2005). Thus, knowledge work- economy’s growth and higher education are somewhat inextricably tied. The following sub-sections attempts to untangle these linkages.

3.2 The unique position of HE in delivering future workforce requirement

Workforce competency is a core requirement for improving employability at an individual level and a country’s growth and productivity, at a macro level. From an individual’s perspective as well, pursuing higher education improves income-generating potential of a person alongside additional non-pecuniary benefits such as prestige. This is also true for a country like the US, where students incur substantial debt to pursue higher education. Even in such circumstances, the earnings premium associated with college is justified as wages rose substantially for both average and marginal students. This increase in wage for college graduates in the US has been driven largely by technological change (Oreopoulos & Petronijevic, 2013). In case of Indian labour market as well, acquiring higher education is beneficial as it is associated with a wage premium. Especially acquiring technical education improves the employability in high-tech sector (Basant & Mukhopadhyay, 2009). Furthermore, the gap analysis between the wages accrued to the different education levels in India confirms that the difference is the highest between secondary school graduates and college/university graduates. This is true for both rural and urban India (Khare, 2014).

Building job-relevant skills demanded by employers is one of the implicit roles that HEIs need to fulfill. Contingent on HEIs ability or inability to deliver for the demand of industries, the popularity of a degree improves, stays consistent or drops, respectively. This phenomenon is further corroborated by Indian youth's perception in a McKinsey study. It was revealed that youths prefer working in occupations that need professional degrees or equivalent higher educational qualifications vis-à-vis certificate or diploma courses. When students who attended vocational programs were interviewed, 55% of the respondents revealed that they were not convinced about their decision (Barton et al., 2013). The McKinsey study further elaborated how in every country surveyed (25 countries with different socio-economic backgrounds, including India), the interviewed youth explicitly stated that academic paths were more valuable than the vocational ones expect for the youths of Germany (Barton et al., 2013).

Compared to alternate routes of acquiring competency, a degree in tertiary education provides credentials indicating an individual's improved capability. The relevance of higher education vis-à-vis vocational or diploma courses is explained by P. Agarwal as follows - "Generalized skills enable workers to develop and implement new technology more quickly. In contrast, vocational education based on narrow skills is useful when technology is changing less rapidly. Therefore, good-quality general higher education, rather than becoming less relevant, is likely to become more relevant in the future. Generic skills that provide flexibility, adaptability, and opportunities for life-long learning will provide young people with the best basis for a career in any area" (Agarwal, 2008).

Worldwide, productive efficiency and economic wellbeing is a function of individual's intellectual and professional capabilities (Khare, 2014). As such, in the era of IR 4.0 when the world of work in undergoing an overhaul, the growth of IR 4.0 is heavily contingent on the professional capabilities of the workforce. Bongomin et. al argue that higher education plays a critical role in moulding the education revolution and subsequently the societal transition accompanying each paradigm of industrial revolution. The challenge with IR 4.0 regime is the pace of change which has bypassed the rate of change of earlier IRs. The Table shows the education system which accompanies the given level of change brought about by each IR and the consequent change in industries brought via improved technology, identified as 'operation-revolutions'. Clarifying specifically on Operator 4.0, the authors contend that, *"Operator 4.0 concept majorly aims to create human-cyber-physical production systems that improve the abilities of the operators. It represents the 'operator of the* *future', a smart and skilled operator who performs work aided' by machines if and as needed"* (Bongomin et al., 2020).

Table 3. 1-Paradigm shift in industry, education and operator

INDUSTRIAL REVOLUTION	EDUCATION (R)EVOLUTION (METHODS)	OPERATOR (R)EVOLUTION (TECHNIQUES)
Industry 1.0	Education 1.0 (dictation and direct transfer of information)	Operator 1.0 (manual and dextrous work) (machine tools)
Industry 2.0	Education 2.0 (progressivism and openness to internet)	Operator 2.0 (assisted work with CNC[2])
Industry 3.0	Education 3.0 (knowledge production and constructivism)	Operator 3.0 (cooperative work with robot)
Industry 4.0	Education 4.0 (innovation production and classroom replacement)	Operator 4.0 (work aided by human-CPS[3])

Source: (Bongomin et al., 2020)

3.2.1 Skill for future employability

Invoking the Human Capital Theory, HE is an effective instrument for improving and building the Science and technology capabilities required in the era of a globalised knowledge economy. Skilling improves employability and consequently accrues economic benefits (Lane & Conlon, 2016) (Liu & Grusky, 2013). However, Hanushek warns that skilling in higher education and not just enrolment is a key determinant for growth. Simply adding more years to education without increasing cognitive skills is not a systemic indicator for growth (Hanushek, 2016).

Hanushek's arguments holds true because, at the surface level, the employability of graduates is apparent given that they have had additional exposure to training. Consequently, an additional degree is conflated with skill acquisition. However, the quandary confronting Indian higher education is the rising case of 'graduate unemployability' (Khare, 2014), whereby millions of youths, despite having availed tertiary education remain unemployed. The cause for this can be extrapolated as

[2] Computer Numerical Control, and commonly called CNC, is the automated control of machining tools (such as drills, lathes, mills) such as 3D printers by means of a computer.

[3]In Cyber-physical systems (CPS) physical and software components are deeply intertwined. As such 'physical' processes impact 'software' and vice-versa. Such an interaction changes with context and operates in different spatial and temporal scales.an examples would be IoT. Effectively, the software- machine-networks and the real physical world becomes intertwined.

follows- there exists an underlying distinction between educational attainment level and the skill level, both at the level of an individual and collectively at the societal level. A high level of education signals the acquisition of high-level skills, regardless of whether such skills are inculcated at the HEIs. This phenomenon partly explains the issue of 'diploma disease'(Dore, 1976).

Nevertheless, this is not to discount HE's relevance as employability is a function of both academic qualification and learning environment that helps build generic skills (Khare, 2014). After all, education is an enabler for individuals to obtain skills. As per studies, this unemployability results from skill mismatch or shortage as graduates are ill-equipped with competencies required by industries (Indian Express, 2020). Employers have repeatedly asserted that skill shortage is the primary reason for entry-level vacancies (Barton et al., 2013). Such a large pool of untapped talent can be attributed to the paucity of future skill-intensive HE. It is essential to remedy this skill deficit, otherwise, if the status-quo persists, the workforce development potential will be severely crippled causing dire economic repercussions.

3.2.1.1 Brief Overview of India's existing Skill & Employability Landscape

As per India Skills Report 2020, the top sectors with the largest hiring were in Banking & Financial Services & Insurance (BFSI), Knowledge Process Outsourcing (KPOs), Information Technology Enabled Services (ITeS) and Internet business. This trend is largely in accordance with the boom of IR 4.0 and the accompanying rise of the knowledge economy. Fortunately, the existing employability pool of employable talents in India. As can be seen from Fig. 3.1, the science and tech graduates clearly have a leverage in being more employable, relative to graduates from other fields.

However, despite their demand, if a global comparison of Indian engineers and their global counterparts reveal how Indian engineers score poorly in terms of having next generational technological skills which include skill set such as data science, data engineering, etc. Moreover, US job applicants are much better off in coding skills than their Indian counterparts, as per the National Employability Report of Engineers (Aspiring Minds, 2019).

This employability deficit is not restricted to the country as a whole but also extends to the states. In addition to poor employability in general, there exists considerable disparity in employability among the states. For instance, the trend of the past five years indicates that the maximum supply of employable talent is accrued from the states of Maharashtra, Delhi, Andhra Pradesh, Tamil Nadu, and UP. Meanwhile, based on employer's preference Tamil Nadu, Karnataka and Maharashtra are the top choices (ISR, 2020).

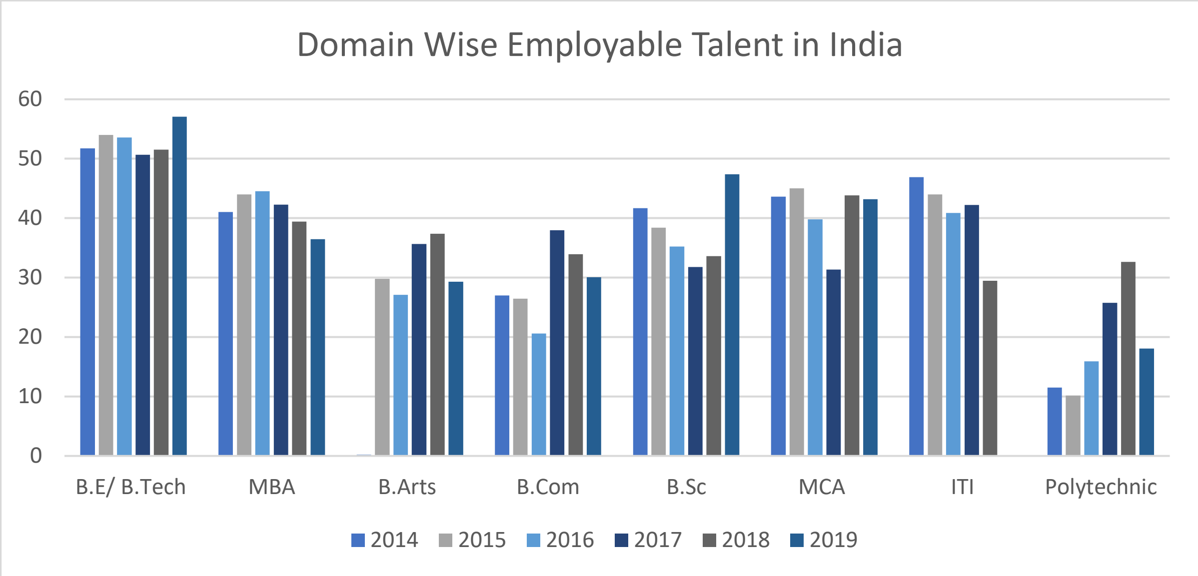

Fig 3. 1-Domain Wise Employable Talent in India

Source : (ISR, 2020)

3.2.1.2 The Constituents of 'future skills'

"The ability to deal with uncertainty is the most important skill in current and future work environments." - (Ehlers & Kellermann, 2019)

Many 'future skills' frameworks have been published, each listing many competencies and some even listing sub-competency. Notwithstanding the array of skill requirements and competencies, the listed skills in different employability models are more broad-based and have a mix of skills encompassing different occupations. Instead of delving deeper into debates regarding the various employability models, the scope of this review if to focus on the skill requirement aligned to support the future growth drivers such as Industry 4.0. this is because there is a certain degree of ambiguity revolving around the precise nature of skills demanded in the future because of the existing undercurrents of change. So, for conclusively arriving at some important skills which are valuable regardless of the direction of the change, the literature reviewed has narrowed 'future skill requirement' to those which specifically cater to the demands of

Industry 4.0. The rationale being, technology is here to stay and emerging technologies as explained in the previous section have an overwhelming influence on growth.

Not only does limiting 'future skills' requirements to 'skills for Industry 4.0' provide some concrete skill requirements. It is also aligned to the existing employability trends whereby the largest proportion of youths employed is from the science domain. The popularity of science graduates in employment stems from the fact that an increasingly larger segment of the employers is concentrated in science and tech domain. A worldwide analysis of employment index shows how these companies are top hirers (Khare, 2014).

This viewpoint is aligned with a study titled 'state of Maturity Report' funded by the European Union (Clavery, 2018), which states how digital skills and people with STEM backgrounds alongside soft skills have unique leverage in standing out among job candidates. The three sought-after IR 4.0 specific competencies include–

1.Technical and engineering competencies

Ability to "apply knowledge of mathematics, science, and engineering; to design and conduct experiments; to analyse and interpret data; to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability; to identify, formulate, and solve engineering problems; and to use the techniques, skills, and modern engineering tools necessary for engineering practice." Moreover, with the increased reputation and authority of HE ranking systems, an investigation into their methodology also reveals a strong bias towards 'Science and Technology'.

2.Business and Management Competencies

Industry 4.0 has drastically changed the management strategy with change in organizational structures with tech-enabled processes used in forecasting, planning metrics, scheduling etc.

3.Design and Innovation Competencies

In facilitating the interaction between robots and humans, design plays a crucial role. Ergonomic consideration ensures human use was taken to consideration and provide better user experience. This competency enables in understanding the impact of technology, designing better user interfaces, service design of tech enabled products and improved user experience.

Other studies have also harped on the relevance of both soft skills/non-cognitive skills alongside more technical and hard skills. For instance, the Delphi study (Ehlers & Kellermann, 2019) on skill, which is one of the most empirically robust studies, laid out a list of future skill demands. A three-pronged classification of future skills was employed, which incorporated (i). Subject and individual development-related skills, (ii). Object related skills (instrumental skills), which is the individual's ability to organize in response to an object, and (iii). Social world/ organization- related skills. These skills were determined especially for higher education so that HEIs can incorporate future skills in their curricula for the future graduates. It argues that these projected broad skill requirements are sensitive in supporting the needs of the future workforce.

Perhaps the popular model conceptualizing the two simultaneous requirements of STEM and other professionals with a greater breadth of cross-cutting competency is the 'T shaped' worker model (Babatope A. et al., 2020) (Barile et al., 2015). Broadly, the framework proposes that a Multiskilled T-worker has deeper understanding of at least one discipline (represented by the vertical bar of T) and cross-cutting competency across multiple disciplines (represented by the horizontal bar of T).

The relevance and power of emotional intelligence on Individual's performance has been repeatedly asserted (Truninger et al., 2018) (Ehlers & Kellermann, 2019). However, there is an inherent limitation in quantitatively capturing emotional intelligence at the macro level, as there exist insufficient data. While proceeding with the research, the inability to capture soft skills, creativity, and other non-cognitive skills is a key limitation of the study.

Numerous studies have delved into the question of skills required for the future of work. However, most of the competence requirement model provide a holistic viewpoint which fails to delve deeper into specific categorization based on unique aspects of IR 4.0 (Hecklau et al., 2017). Narrowing these skills and identifying a few common 'skill' components specific to industry 4.0 is tabulated in Table 3.2.

Table 3. 2-Common 'skill' components specific to industry 4.0

SKILLS	LITERATURE IN SUPPORT
Soft Skills / Social traits or Non-Cognitive Skills • Since soft-skills are uniquely human, they become vital with the rose of machine adoption. The ability to communicate, be creative, have curiosity etc. are qualities which cannot be replicated by machines and as such are non-substitutable skills	(Ehlers & Kellermann, 2019) (Clavery, 2018) (Hecklau et al., 2017) (Fitsilis et al., 2018)
Team Work • The ability to work alongside co-workers in a cordial and cooperative manner is one of the key traits demanded by employers. Even in R&D which is largely a collaborative effort, the capacity to work together is essential	(Ehlers & Kellermann, 2019) (Clavery, 2018) (Fitsilis et al., 2018) (van Laar et al., 2017)
Hard Skills or Technical Skills • Specific knowledge required for performing specific occupation (mostly requires some training or prior experience). These skills are vital for coping with the 'technical' element of the emerging technologies – in further creating new software, understanding the standards, ensuring digital security etc.	(Hecklau et al., 2017) (Clavery, 2018) (Fitsilis et al., 2018)
Cognitive Skills • Often synonymously used with IQ, it can be further sub-classified into three aspects: 1. verbal aptitude (i.e., vocabulary, spelling, and reading), aspect two, 2. numerical aptitude (i.e., math, arithmetic) and 3. spatial aptitude (i.e., coordination, memory, decision-making, problem-solving thinking, abstract reasoning, analytical thinking). These are vital skills required process information, reason etc. As such, they are also in some ways fundamental skills.	(Hecklau et al., 2017) (Clavery, 2018) (Ehlers & Kellermann, 2019)
Emotional Intelligence (EI), or emotional quotient (EQ) • It is the capacity to perceive, understand and regulate emotions in oneself to lead thinking and actions. This competence has a strong influence and contribution towards satisfaction, commitment, motivation, performance, stress and quality decision-making of employees, because it supports in complex control activities. Moreover, individuals with high EQ are expected to achieve easier success at their commitments, whether personal or professional, due to better ability to handle new challenges and resilience to frustration and stress.	(Clavery, 2018) (Truninger et al., 2018)
Digital skills • Some studies conflate them with are the dexterous abilities for understanding and using digital content, devices and systems to perform activities. However, these skills also incorporate numerous other competences, namely, cognitive, social or technical, to perform activities in the digital world. Unlike	(Clavery, 2018) (van Laar et al., 2017)

SKILLS	LITERATURE IN SUPPORT
technical skills, they are more generic and encompassing of all technologies.	

Even if one were to consider the core-work related skills required The World Economic Forum, adapting the O*NET's framework of classifying skill (World Economic Forum, 2018), segregates skills into 3 categories and 9 sub-categories as shown in Table 3.3. An interesting observation can be deduced from the sub-skills, as most of the them are somewhat higher order skills. Most of the skills mapped under 'abilities' and 'cross-functional' skills, build up on basic skills taught in schools, thereby further justifying the case for higher education's relevance in churning future workforce.

Table 3. 3-World Economic Forum Framework of classifying skills

ABILITIES	BASIC SKILLS	CROSS- FUNCTIONAL SKILLS	
Cognitive Abilities **Cognitive Flexibility** **Creativity** **Logical Reasoning** **Problem Sensitivity** **Mathematical Reasoning** **Visualization**	**Content Skills** Active Learning Oral Expression Reading Comprehension Written Expression ICT Literacy	**Social Skills** Coordinating with Others Emotional Intelligence Negotiation Persuasion Service Orientation Training and Teaching Others	**Resource Management Skills** Management of Financial Resources Management of Material Resources People Management Time Management
Physical Abilities **Physical Strength** **Manual Dexterity and Precision**	**Process Skills** Active Listening Critical Thinking Monitoring Self and Others	**Systems Skills** Judgement and Decision-making Systems Analysis	**Technical Skills** Equipment Maintenance and Repair Equipment Operation and Control Programming Quality Control Technology and User Experience Design Troubleshooting
		Complex Problem-Solving Skills Complex Problem Solving	

Adapted from Futures of Job Report, based on O*NET Content Model (World Economic Forum, 2018)

3.2.2 Higher Education as a conducive space for R&D and Innovation

The role of Higher Education Research and Innovation (HERI) in knowledge-based societies is tremendous as it directly augments two ingredients of a high-tech industrial base – firstly, by generating new knowledge for innovation and secondly, by producing highly skilled personnel who can subsequently be incorporated in the R&D sector of an economy (be it in academic, government, private sector etc.) Graduates who have the ability to undertake research and are absorbed in industries bring forth knowledge of new scientific research to the industries. This is reflected in the growing trend of students trained in basic research switching over to industries and making solid contributions therein. Thus, the research function of academia is a key source of knowledge and innovation in any economy.

For a country like India transitioning from a factor driven country to efficiency driven and eventually aspiring to be an innovation driven economy, a high-tech industrial base is critical for materializing development. For R&D to support growth, it is crucial to enhance the higher education research system that serves the knowledge society of ours. Knowledge production in higher educational institutes and notably in universities have witnessed a surge in the past century. Knowledge that is produced from research is the basis of development as converting new knowledge into an application, can aid in value addition to existing systems. Although the exact mechanism of organizing HEIs is a question lurking both advanced and developing countries alike, the relevance of transmitting tactic knowledge from academic practitioners to industry is founded on solid theoretical premise.

Such theories make a case for higher education institutes in fostering R&D and consequently economic growth, elaborating on the role of higher educational institutes. For instance, the National Innovation System (NIS) approach is one paradigm that argues that "the flows of technology and information among people, enterprises and institutions are key to the innovative process. Innovation and technology development result from a complex set of relationships among actors in the system, including enterprises, universities and government research institutes" (OECD, 1997). The interacting agents being firms, universities (such as research institutions) and government are vital for improving an economy's innovative capacity. Furthermore, the approach emphasizes how for NIS to translate into economic development, the science base of a country needs to be strengthened alongside experience-based learning (Lundvall, 2007).

The role of universities in the NIS has been empirically proven as well. For instance, China's success in innovation results from its successful linkage between university-research institutes and industry linkage (Xiwei & Xiangdong, 2007). This is a universal trend as it is evident that all countries with robust innovation systems prioritize research whether it is in universities or the private sector (Meek et al., 2009).

Another theoretical paradigm of 'Triple Helix approach' builds up on the NIS framework and establishes a direct relationship between troika of university, government and the industry, in building a knowledge-based economy (Leydesdorff, 2012). However, based on the University-Industry-Linkage (UIL) model, of the three spokes emphasized by NIS and the triple helix model, UIL contends that the relevance of university and industry supersedes that of the government for fostering innovation.

The UIL paradigm argues for bringing universities closer to the market, improving the invention-innovation diffusion process. Many studies also focus on policy measures that enable the evolution of traditional universities to become entrepreneurial universities. Thus, the UIL paradigm is concerned more with the commercialization of created knowledge by HEIs and not just the potential of HEIs to supply skilled labour (Etzkowitz, 1998). Nevertheless, this model is perhaps more suited for countries pushing technological frontiers such as the US, where universities such as Stanford University, MIT, Harvard, UC Berkeley function as 'college incubators. Baring a few exceptions of the elite IITs, in India, the labour market link is prioritized much more.

This is further backed by an analysis of India's innovation system, which reveals that India is emerging as an important hub for R&D, especially for larger and medium sized firms, across different sectors. Such a trend in development is mainly owing to the skilled labour pool. Nevertheless, the study cautions that quality of institutes is sub-optimal and below the standards required for producing cutting edge R&D results (Herstatt et al., 2008).

3.1.1.1 India's R&D and Innovation capacity for delivering IR 4.0 requirements

The role of R&D is key in supporting Industry 4.0, which is one of the key growth drivers of the future, is immense. Worldwide, evidence of academic research supporting I.R 4.0's growth is robust. Despite the enabling role of academic research in enabling innovation of IR 4.0, to answer how far India's current academic research catered to the need of Industry 4.0, Medhi (Medhi, 2019) conducted a study using text mining approach for selected academic research papers related to the topic of IR 4.0 in reputed trade journals, blogs, technology magazine in the four years preceding the study. The results divulged that the existing research addresses a few selection gaps in the knowledge production process, and limited research has the scope of being further translated into practice. Despite the fact that there has been a considerable amount of research in the space, there is immense opportunity for work as the scope for growth in the research are of IoT, AI, blockchain etc. are abundant. Moreover, some areas of IR 4.0 are yet to garner adequate attention.

Comparing Indian and Chinese universities based on the high-impact academic research and world university ranking, China emerges victorious on both fronts. In a study, it was revealed that four factors are spearheading China's scientific research – a large population which implies a greater human capital base, academic meritocracy being rewarded in the labour market, greater proportion of Chinese origin scientists worldwide and finally, the government's enormous investment in science (Xie et al., 2014). Ironically, the first three factors are consistent even for India, and yet, the research quality and output chasm have only expanded. China's improvement is noteworthy because its science and technology university research output increased by 17% during the period 2000-2012 compared to 4% in the US during the same period (Reddy et al., 2016)

India's backlog in research for Industry 4.0 is consistent with its policy neglect of research capacity historically. This is evident from the poor government expenditure on R&D as a percentage of GDP compared to innovation-driven countries like Israel, Sweden, Japan, US, etc. The neglect has morphed into a situation where there is a divorce of research from teaching, with research inclined faculty being in low supply (Basant & Mukhopadhyay, 2009). Within India as well, the research capacity is not uniform across the state. With huge inter-state disparities in R&D capabilities as well opportunities. It is a mounting challenge for states to build a research infrastructure, especially in teaching-centered universities. This is especially true for low-income states to support research facilities for Higher Education Research when even the state of basic infrastructural facilities is unsatisfactory (Agarwal, 2008).

3.3 The Challenges Confronting India's HEIs

HE in India has several inherent issues- most notably, the uneven quality across states. The system of HEIs is severely fragmented, which further gets aggravated by the concentration of industries in specific pockets of the country. Despite the spur in the growth of professional degrees, a significant part of India's HE sector is neither job-oriented or research-oriented. Most of the better stock of HEIs is clustered in a few states – most of which are urban and rich. Consequently, the job opportunities and industries are scantily concentrated in a region well-endowed with elite HEIs and industries. Most public universities in rural areas are underfunded (sadly, the funding mechanism is also skewed in favour of the elite institutions) with deteriorating infrastructure, understaffed falling standards of education (Agarwal, 2008). Other challenges in Indian higher education include poor academic research, deteriorating GER, lack of placements, dearth of industry-oriented research, absence of a mechanism for gauging quality and assessment of practice, insufficient financial support, and political interference (Reddy et al., 2016). The issue of quality continues to plague the education sector. While the growth of HEIs in response to the high-tech sector has been encouraging, the quality of response is not as encouraging (Basant & Mukhopadhyay, 2009). Thus, enhancing access while maintaining equity should be the priority.

The students concur with the torrid state of affairs. As per a McKinsey survey of Indian youths, the major disincentives of studying include scepticism about quality and value addition (21%), affordance (18%), lack of interest (16%) and insufficient capacity (14%). Moreover, close to 50% of the youths were ill-informed about educational choices (Barton et al., 2013).

The literature in the above sub-section establishes that HEIs contribute to economic growth by providing a workforce who are both innovators as well as by providing skilled workers improving the productivity of the economy. However, with regards to research capacity, the constraints imposed on the higher education system are intense as there exist few opportunities in the research domain, a weak research ecosystem, and dismal industry engagement. This issue has been aggravated by the segregation of teaching and industry research. This limitation is evident from the fact that Indian HEIs continue to struggle to make a mark in the global university ranking lists that place a high weightage on research. Meanwhile, with regards to skilled workers, the rise in the proportion of population with a higher education level does not lead to a concomitant rise in the proportion of highly skilled people. This is a challenge to assess because of the diversity & heterogeneity of even same degree courses in different HEIs. So, the productivity of an individual relies both in their domain expertise and the institute.

Alongside HEIs, complementary institutions and facilities help foster the innovation environment – to realize the potential by connecting them with supply-chain and endowing them with resources. Complementary infrastructure ensures that there exists absorptive capacity both to employ skilled personnel and utilize research findings. Without local receptors, whatever a university produces will be exported elsewhere to a different state- although this does lead to the spurring growth in the economy at larger, it leaves some states at a clear-cut disadvantage. As such, HEIs are a necessary but not sufficient condition driving economic growth.

The preceding analysis shows how despite the efforts to widen the spread of HEIs in the country and the concomitant massification of higher education, institutes continue to flourish in certain states and regional pockets. Multidimensional inequalities get exacerbated through the issue of enrolment across populations and geographies. Such uneven growth has a crippling effect on the country's economic growth potential and needs to be scrutinized.

3.4 Research Gap

The direct correlation between Higher Education and the workforce has been extensively researched from the standpoint of skill development, productivity, and contribution to growth. Although numerous papers scrutinize the undercurrents of the future workforce, such as employability, skills, research, and the relevance of higher education for high-tech industries, such papers have delved into workforce development and higher education in silos. There is limited literature investigating the intersection of higher education and the future workforce, and such an inquiry is absent for India. The missing piece in the puzzle is a big-picture overview incorporating all the dimensions mentioned above, which can conclusively reveal the preparedness level of India's higher education sector in meeting future workforce requirements.

The other strand missing in the literature is the inter-state disparity in HEI's potential in meeting the future workforce. Although a few papers have covered regional disparity in higher education, a state's ability to meet workforce requirements is a crucial area of interest that remains unexplored. While it can be argued that the India Skill Reports and similar employability report indicates regional workforce deficiencies, it glosses over the R&D and innovation aspect. Moreover, such a report remains silent about the HEIs quality and accessibility, which continues to cripple India's HE sector.

This paper is an exploratory research attempting to understand the nuances of the linkages between higher education and the workforce in fostering growth and driving competitiveness. In establishing a linkage, the paper attempts to provide a framework that collectively captures the relevant factors in HE that affect the economy's propensity to innovate and improve efficiency by contributing to workforce development.

3.5 Conceptual Framework

Based on the reviewed literature, it has been established that Higher Education contributes directly to improving the skill level of the graduates and an individual's potential to conduct research (depending on the level of higher education such as Ph.D., M.Phil. etc.). These two functioning of higher education is directly related to workforce development. Since the scope of the literature is the 'future' workforce, and Chapter 2 already evaluated the potential growth drivers of future industries, enhanced employability of graduates directly feeds into improved productivity of such future firms. Meanwhile, academic research is a massive contributor in propelling the innovation level of an economy. Such augmented productivity and innovative capacity further lead to economic growth. This flow which incorporates the input process underway in higher education, leads to economic growth.

One important caveat in this depicted 'flow' is that only quality HEI can deliver a high-quality workforce. Since quality is a highly subjective phenomenon, a proxy measure needs to be incorporated. However, the relevance of the 'quality' and 'accesses' of higher education is equally important in determining the extent of productive capacity of the future workforce. In the backdrop of massification of HE which has led to compromise on quality, a parameter for measuring quality is indicative of the maintained standard in institutes. The same degree offered by different institutions can lead to the varying capability of the graduates based on the quality of the graduates. Similarly, access measures the participation rate of the youth in HE to gather insights about the proportion of the workforce who are trained. As has been already established, the sophistication of emerging work profiles in high-wage, high-skills jobs is biased towards S&T capabilities –the capability to innovate or the technical know-how to function with emerging technologies. Thus, in each ‘level’ of the flowchart, the capabilities assessed in the paper will be in accordance with the theoretical constructs and empirical evidence supporting the links.

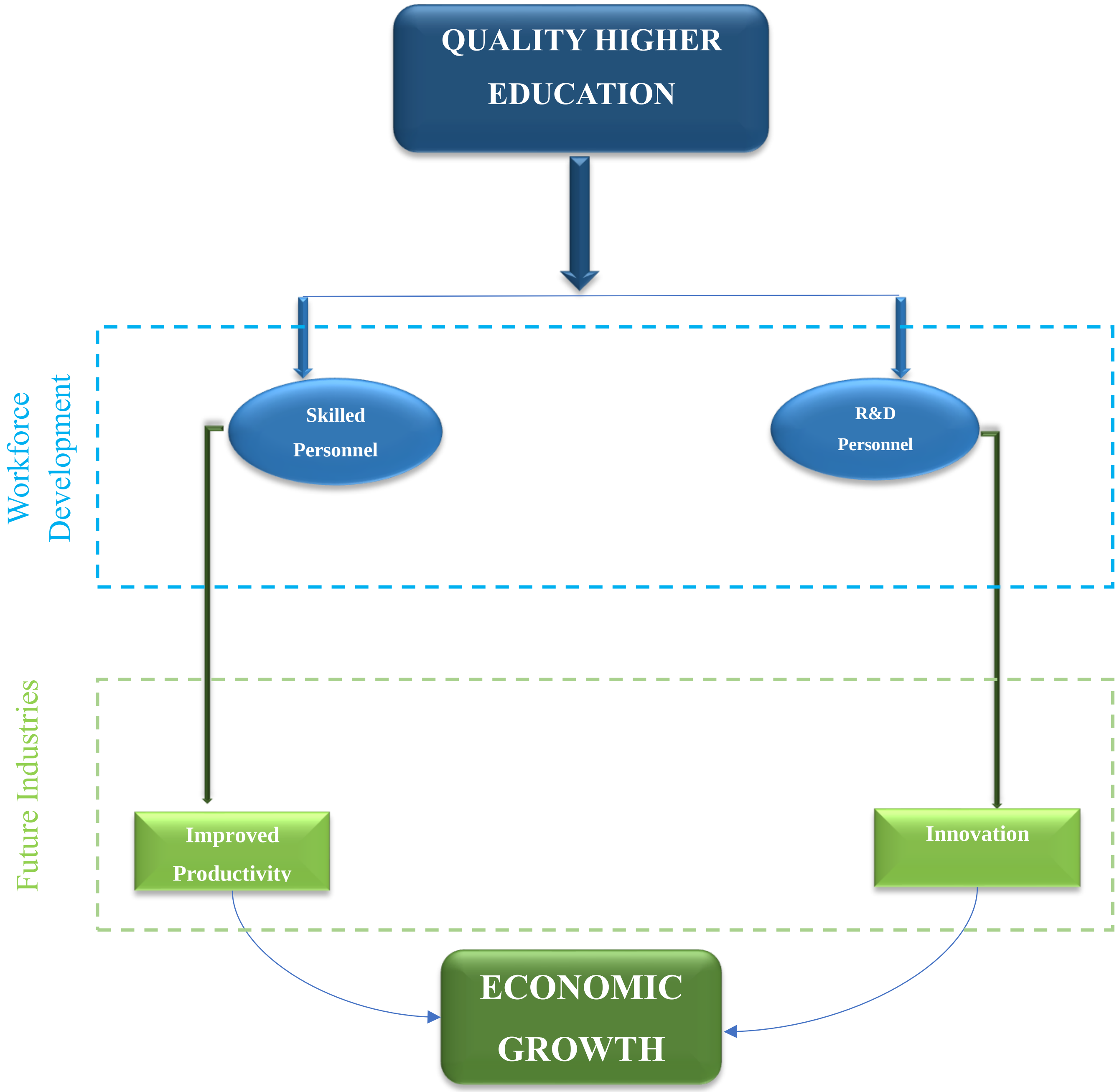

Fig 3. 2-Conceptual Framework

CHAPTER 4

HEFW INDEX – AN EXPOSITION OF THE ADOPTED PROCEDURE

4.1 Introduction

The factors that influence Higher Education's ability to deliver for the Future Workforce requirements are varied. Such multidimensional indicators further interact in complex mesh of feedbacks between them. An indicator or dimension is defined as a variable describing a particular trait of an aspect. Each indicator reveals some information about the position of a phenomenon being evaluated. However, when there are numerous indicators, it is best to depict them in a categorically classified framework. The issue with adopting this approach is the challenge of deciphering common trends across different indicators. Studying multiple indicators can be confusing if the ranking varies with each indicator. This is where the alternate approach of Composite Indices (hereon referred to as CI) comes in handy. It helps in condensing the size of the indicators without any loss of information. As such, more indicators can be studied collectively- which succeeds in providing a big-picture view. An index effectively aggregates numerous quantitative indicators to arrive at a value that provides information about the larger phenomenon studied (Mayer, 2008).

Simply put, numerous indicators are compiled to form a single index on the basis of a designed framework or model. In essence it is an easy way to encapsulate multidimensional features, which is easy to interpret relative to a gamut of indicators in silos. The eventual objective is to construct an appropriate composite index CI, mapping different multidimensional indictors, $x^s = (x^s_1, x^s_2, x^s_3 \ldots\ldots x^s_m)$ where x^s is state wise indicator, so that the states can be appropriately ranked.

As the notable physicist William Thomson put it, *"What is not defined cannot be measured. What is not measured, cannot be improved. What is not improved, is always degraded."* CI has another added benefit of being easy to understand and thereby succeeds in garnering public attention as well. This is evident from the popularity of indexes such as Human Development Index (HDI), Global Competitiveness Index (GCI), Ease of Doing Business (EoDB) etc. Given the public interests it garners, they consequently become a policy priority and promote accountability. It also helps make the case for the issue studies and brings forth a narrative for a larger audience. Thus, the proposed index is a good starting point to initiate discussion about this topical and yet ignored issue of assessing the current status of higher education in providing for a suitable future workforce and by extension, devising an apt workforce development policy geared towards addressing the weakness.

4.2 Relevance of using a Composite Index as the foundational methodology for this study

One of the primary objectives of this study is to understand how well India's Higher Education sector is aligned to support and meet the future workforce requirements. To achieve this, a holistic view of the indicators in Higher Education that conclusively aids in building the future workforce needs to be accounted for. The challenge confronted while undertaking this was an increasingly large number of indicators, each revealing information about a different characteristic. These variables were selected based on the criteria that affect the capabilities of the workforce currently pursuing Higher Education in India, such as skill, employability, innovation, and knowledge production. All these features are relevant to analyse the performance of HE's future workforce potential. Accordingly, constructing a CI makes viable sense to comprehend this large amount of data, which cumulatively is telling of the phenomenon. Thus, the CI, as a scale measurement helps circumvent the issue, when a phenomenon cannot be measured by a single item or question. the constructed Index is termed as Higher Education Future Workforce (HEFW).

The other objective of the study is to assess the existing inter-state variation (and disparity, if any) in meeting the future workforce requirement. Since CI is an ordinal value, it helps assess whether the phenomenon or system as a whole being studied is improving or worsening relative to other country/states/ regions etc. Alongside, it also distils information on a per country/region basis about the relative performance of each sub-index (as has been incorporated in this index). In this case, the Index enables comparison of states. The relative performance of the states can be assessed by the gap between higher ranked states, lower ranked states, better performing state etc., as judged by the index. Thereby the CI enables comprehending the complexity of multiple parameters revealing the status of current higher education paradigm in achieving workforce requirements. The ordinal values of the index, while enabling an inter-state comparison and also provides a yardstick against which a state's development can be measured. Furthermore, the index can also be used in a longer time frame as in the future it can help assess the progress over time as and when the indicators are updated. This is also helpful in designing policy priority in lagging states while providing an overview for mitigating the interstate FWFD potential attributed/ arising from higher education.

4.3 Steps for Constructing the HEFW Index

Since the decision made at one level critically influences other levels, the following section outlines the step-by-step guide adhered while constructing the index. While each level is equally important, it is ultimately the consistency throughout the whole process which ensures the robustness of the index. To ensure transparency, the section further talks about how the decision to use a particular method at each level was arrived at. The subsequent sections also touch upon a few other alternative approaches, which were given due consideration at different steps, alongside laying out the rationale for rejecting or selecting an approach. Thus, the sub-section explains the methodological choices undertaken in detail.

4.3.1 A Brief overview of step-by-step procedure for an Index construction

The HEFW index constructed here has a two-layer hierarchical structure of variables composed of several indicators. The term 'indicator' is used for the lower hierarchical level, while the term 'dimension' or 'sub index' is used for the higher hierarchical level. The lower-level indicators are aggregated to form the sub-indices, and these sub-indices are further aggregated to form the CI.

Meanwhile, the chief elements in building the HEFW index include selecting appropriate indicators, weighing them, and finally aggregating them into a CI. The most challenging aspect is deciding the weighing and aggregation methods. Weighing can be considered as assigning importance, while aggregation accounts for the substitutability of the indicators. Taken together, these two aspects determine whether individual dimensions can compensate for each other and to what degree. The other steps are equally important as each stage informs the next step. Fig.4.1. depicts the flow of the steps, each of which is elaborated in detail in the following sub-sections.

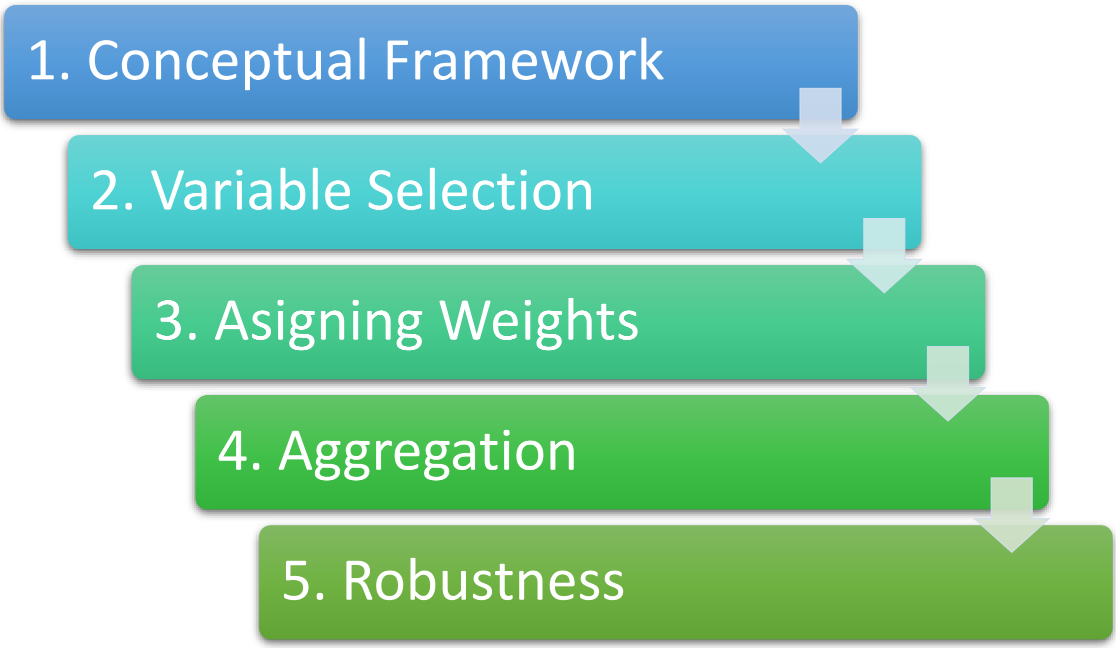

Fig 4. 1- Step-by-Step method of HEFW Index Construction

4.3.2 Developing the Conceptual Framework

The conceptual framework or the theoretical pillar is vital to understanding the index and its multidimensionality. It enables easier processing of how and why the sub-groups constituting the whole measure came about. In a way, it is the base from which variable selection and combination is made to ensure that the ultimate index arrived upon is meaningful and serves the purpose for which it was intended. According to the OECD, beyond the data used and the methodology followed, the soundness of a composite index relies heavily on the theoretical background and the framework from which it has been adopted (Nardo et al., 2008).

From the literature reviewed in the previous chapter, we arrive at a few important determinants of Higher Education's effectiveness in contributing to future workforce development – the access of young adults in the higher education space, the quality of HEIs, the skill level of those enrolled and finally the research capabilities of HEIs as it directly feeds both innovation and knowledge production. Clubbing access and quality, the resultant framework obtained is depicted in Figure 4.2, the three differentiating thematic areas further helps in clustering similar indicators. This approach of clustering into subcomponents before finally aggregating is also employed in the Ease of Doing Business (which has ten thematic dimensions).

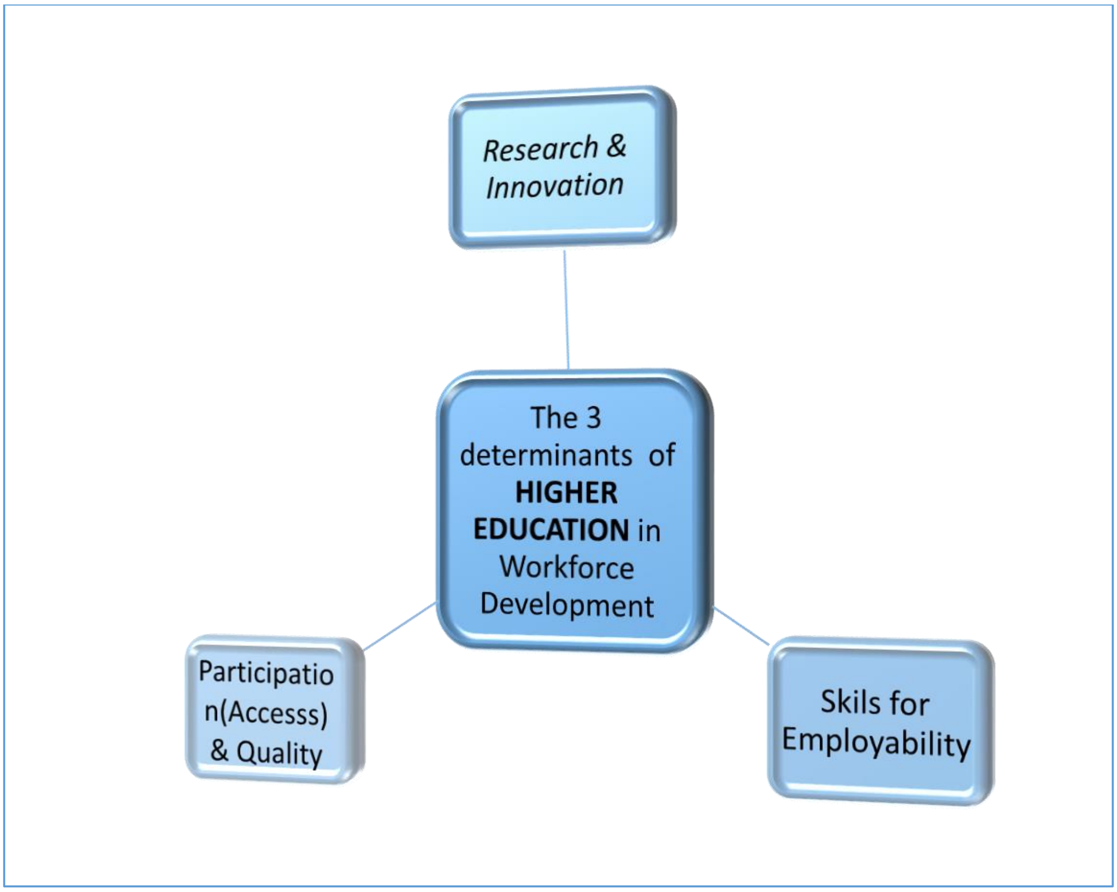

Fig 4. 2-Higher Education & Future Workforce Development - the three determinants

4.3.2.1 Arriving at the Sub-Indices from the Conceptual Framework

This conceptual framework provides the rationale selecting variables in the next stage and is the blueprint guiding the construction of HEFW composite index. To facilitate thematic classification in selecting indicators, the final composite Index of HEFW is an aggregation of three sub-index. Each sub-index representing either one of the three dimensions of skills, research or access & quality.

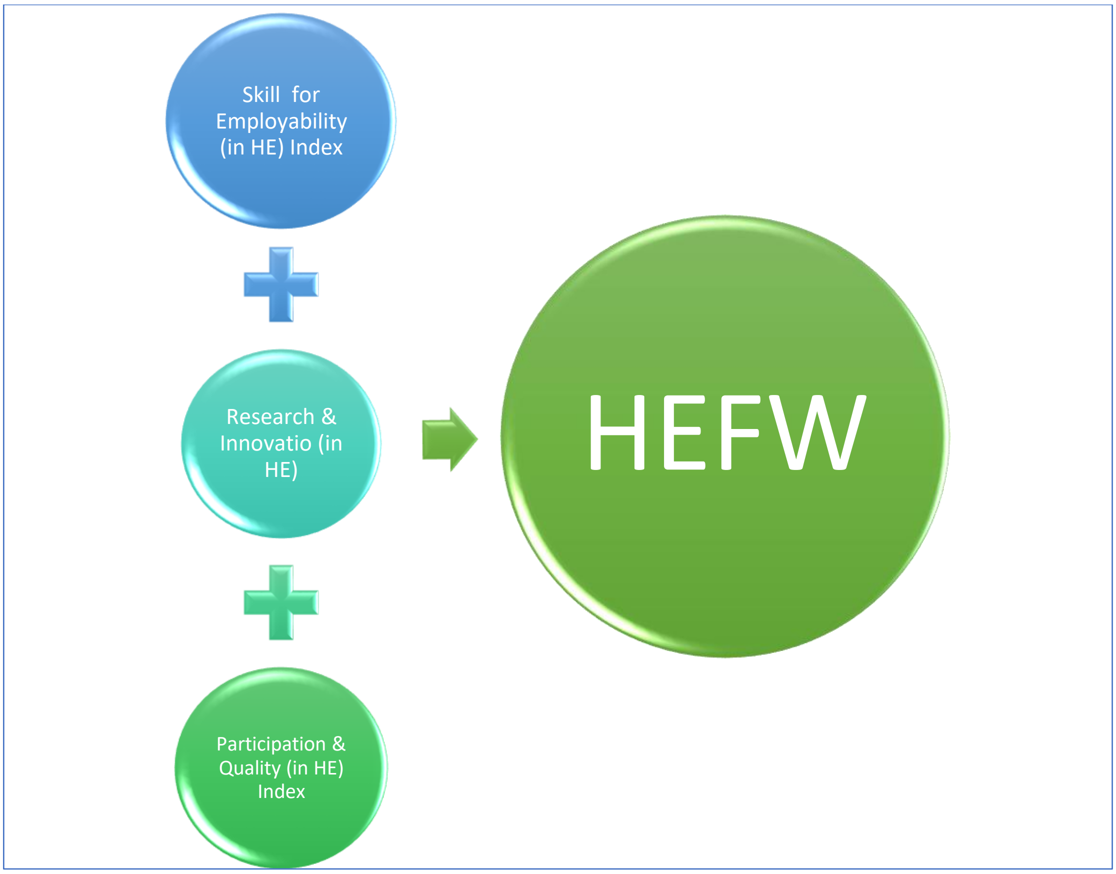

Fig 4. 3-The three Sub-Indices of the HEFW Index

4.3.3 Selected Variables and their significance

"An Index is Driven by the Behaviour of its Indicators" (Mayer, 2008)

Since there are three key dimensions in consideration, for each dimension, indicator selection was based on data availability and data reliability. Since the index is broadly a macro measure, in its entirety the index relies on secondary data alone. To ensure reliability of data, only data from government published sources have been included. As per literature, there is no hard and fast rule about the exact number of indictors/variables which needs to be incorporated. For instance, the HDI uses just six indicators while Worldwide Governance Indicator uses over 300 indicators. As such, given the availability, only 11 indicators are selected. Broadly, all the selected variables had a few commonalities: ease of measurability, significant coverage of states, the relevance of the variable to the subcategory being measured.

Each indicator is included only after considering its measurability and relevance to the sub-index. Only those data have been included which has broad coverage across the different Indian states, and no proxy variables were used. The overall data selected are meaningful in representing the dimension and, by extension, the holistic field of higher education's future workforce potential.

The following table provides a comprehensive overview of the selected indicators, the basis of their measurement, and how they are significant in providing reliable information about the dimension.

Table 4. 1- Selected Indicators of HEFW Index

Indicator Name	Notation	Description	Data Source	Significance
HIGHER EDUCATION ACCESS AND PARTICIPATION INDEX				
Gross Enrolment Ratio (18 to 23 yrs.)	GER	(No. of 18-23 years enrolled in Higher Education / Total no of 18-23 yrs. old) *100	Economic Survey – 2020 (2018-19)	To determine the number of youths aged 18 to 23 yrs.' who took admission in Higher Education – this provides information about participation
A and above ranked colleges as per NAAC	NAAC	Percentage of Institutes with NAAC ranking A & above (of the total institutes accredited)	NAAC (2018-2019)	Since 'quality' of HEI is an elusive concept, A and above ranked institutes are used as an indicator of relative quality superiority
Net Attendance Ratio[4] (18 to 23 yrs)	NAR	(No. of 18 to 23yr old attending HEI / No. of students who took admission) *100	Economic Survey 2020 (2018-2019)	Attendance is an indicator of both participation and to an extent even quality
RESEARCH AND INNOVATION INDEX				
Connectivity to National Knowledge Network	NKN	Percentage of NKN connected Higher Educated Institutes connected to NKN as a proportion of total no of	AISHE (2018-2019)	NKN is a research and education network with the objective of providing high speed network for educational institutes. It provides the global scientific

[4] It was incorporated only for the Normal Category States as data was missing for Special Category States

Indicator Name	Notation	Description	Data Source	Significance
		Higher Education Institutes in the state		community with high-speed network, which is a vital precursor in conducting research
Atal Ranking of Institutions on Innovation Achievements (ARIIA) ranked institutes in the states	ARIIA	No. of HEIs which appeared in the ARIIA ranking of 2020	ARIIA – MHRD (2020)	It ranks all major HEIs of India on the basis of numerous indicators indicating 'Innovation and Entrepreneurship' development both among the faculty members as well as students
R&D Expenditure of the states	RDE	Percentage distribution of R&D expenditure by different states	R&D Statistics (2017-18)	Provides estimate of the expenditure incurred by the state governments on R&D
SKILL FOR EMPLOYABILITY INDEX				
Capacity Building and Training Awareness Programme	CBT	Percentage of Institutes with Capacity Building and training as a proportion of total no of Higher Education Institutes in the state	AISHE (2018-19)	It provides information on the institutes where capacity building and training awareness program was conducted. Such training programs are beneficial in
Skill Development Centre	SDC	Percentage of Institutes with Skill Development Centre as a proportion of total no of Higher Education Institutes in the state	AISHE (2018-19)	The availability of Skill Development Centres is indicative of whether HEIs are focussed on skilling the student and by extension increase their employability
National Mission in Education through Information and	NMEICT	Percentage of Institutes with Connectivity NMEICT as a	AISHE (2018-19)	A Central Sponsored Scheme, it aims to leverage the

Indicator Name	Notation	Description	Data Source	Significance
Communication Technology		proportion of total no of Higher Education Institutes in the state		potential of ICT in HEIs (by providing connectivity, bridge the gap in skill to use computing device, etc.)
Computer Centres	CC	Percentage of Institutes with Computer Centre as a proportion of total no of Higher Education Institutes in the state	AISHE (2018-19)	The availability of computers in a HEI is representative of how much support students have in terms of accessing ICT devices. Familiarity with computers is a key part of technology literacy and consequently one of the 21st Century skills
Assistance to Universities for Technical Education[5]	TUE	Percentage of technical education expenditure in university as a proportion of all expenditure	Annual Budget Expenditure Report MHRD (2016-17)	This helps in assessing how much endowment universities receive specifically for improving the technical education in states

Each indicator is either an input, an output or a process constituting each of the dimensions. Each included is a key aspect of the index and impacts both weighting and resulting value of the CI. The problematic aspect is if data is missing or unavailable for the majority of the indicators – to ensure this issue does not arise, only those indicators have been included, which have sufficiently large data points covering all states.

4.3.4 Normalizing the Data

Aggregation and weighting make sense only when indicators are comparable, and for that, they need a common basis or scale. Since the indicators used have a variety of data, differing in the values and measurement units, comparing them together would be

[5] It was incorporated only for the Normal Category States as data was missing for Special Category States

like comparing apples and oranges. So, normalisation is undertaken to ensure the range of variability for each indicator is similar. This means that various scales of different indicators are transformed into one common unique scale, rendering them comparable. Only the normalized indicators are assigned weights and aggregated. To an extent, even normalisation is somewhat a weight assigning feature as it is based on the assumption that all indicators should be on an equal variability range (Lindholm et al., 2007). Data transformation also avoids giving too much importance to outliers or extreme values to prevent skewness.

The most popular normalization techniques include standardization (z-scores), ranking, distance to a reference measure, cyclical indicators, categorical scales etc. The normalisation approach adopted here is linear transformation using the 'Max-Min' approach. Symbolically can be expressed as:

$$x_i' = \{[x_i - \min(x_i)]/\{[\max(x_i) - \min(x_i)]\}$$

where, x_i' is the normalised value of an indicator.

Min-Max normalises indicators and the process ensures that all the input variables are commensurate, with each indicator having an identical range [0, 1]. This is achieved by subtracting the minimum value of the indicator and dividing it by the difference of the maximum and minimum value of the indicator.

4.3.5 Assigning 'Weights'

The weight indicates the importance of each variable in contributing to the phenomenon being calculated via the composite index (Schlossarek et al., 2019) i.e., how much each variable influences the score of the overall index. If a given index (say *b*) measures the performance of a system, then a higher weightage of the variable '*b*' vis-à-vis other variables, will lead to '*b*' having a stronger influence on the final index. Thus, in a way, the assigned weights show the importance of each specific dimension.

Furthermore, weights also determine the substitutability of one dimension for the other. Whether it is a sub-index or a variable incorporated in a sub-index, a small change in either can or not compensate each other, depending on how weights are assigned. For instance, assuming there are two dimensions – a and a' and assuming we take the ratio of the dimension specific weights as *(a/a')*. In this case larger the weight to dimension, the more one is willing to give up of *a* to compensate for an extra unit of dimension *a'*. This is why the choice of the weights has an overwhelming impact on how the final composite index turns out. Weights reflect the relative importance of one component vis-à-vis the other components. Because of its direct impact on the value of CI as well as determining the substitutability of a variable, inappropriate selection can lead to misleading results. As such, it is one of the most challenging aspects of index construction.

Types of weights can broadly be classified as Data driven, Normative and Hybrid (mixture of the two). In the case of the data-driven procedure, the weights are chosen as per the distribution of individual indicators. In case of Normative procedure, only value-judgement is employed on the trade-offs of assigning weight and selection is not based on the distribution of x. The Hybrid method employs a mixture of both approaches by using information both from the distribution of x as well as value judgement.

To narrow down on a select approach to allocate weights, a scrutiny of alternate weightage method was conducted. The Data Driven method (or statistical basis) of assigning weights includes Principal Component Analysis (PCA) and Factor Analysis (FA), Unobserved component model, Benefit of Doubt (BOD) approach etc. Likewise, the Normative method of assigning weights includes the Equal Weighting, Public or Expert opinion, Analytical hierarchy process (AHP), Budget allocation Process (BAP) etc. (most of which use value judgements of experts).

After due consideration to popular alternatives, the equal weighting method was zeroed upon. The rationale for rejecting other alternatives is listed in Table 4.2. The first rationale for setting equal weights for each component is because there is no solid theoretical framework supporting an alternate weight assigning scheme or which dimension should be given more weightage. Without any alternate objective mechanism to determine relative importance, this is the best-case approach. And broadly defensible (Seth & McGillivray, 2018). The second motivation for selecting this weighing method is that this approach was initially used by the pioneering UNDP Human development Index developed in 1990, arguably the most influential composite index. Likewise, equal weights have become somewhat of a norm with other popular indices such as Ease of Doing Business, Index of Economic Freedom, Global Peace

Index, child Well-being Index etc. Thirdly, its simplicity ensures an intuitive understanding of the procedure. Thus, the weight assigned to each dimension is uniform and is also in accordance with Occam's razor of using the simplest possible alternative.

Table 4. 2- Alternate (Popular) Weighing Methods & rationale for their rejection

Alternative Weighting Methods	Type	Rationale for rejection
Principal Component Analysis /Factor Analysis	Statistic-based	A rule of thumb postulates that there should be at least 10 cases (in this case, state) for each indicator (Nardo et al., 2008). Other others also content that the case-to-variable ration should be high. Since the number of variables does not qualify this rule of thumb, this was rejected.
Benefit of Doubt Approach	Statistic-based	Complicated for the existing data set and multiplicity of solutions exist
Regression Analysis	Statistic-based	The weights here are the regression coefficient of each indicator. However, in this case there is no proper dependent variable to conduct the regression
Budget Allocation Process or Expert Opinion Based	Public/Expert opinion-based	Experts are required to 'budget' one hundred points to the indicator set. It relies too much on subjective evaluation and can be perceived as arbitrary. Value-judgement also susceptible to technical manipulation and most often, beliefs are inconsistent. Since selection bias can aggravate the skewedness of weightages resulting in uninformed index, this approach was omitted.

It is worth noting here that 11 indicators for Normal Category States and nine indicators for Special Category States have been grouped into three dimensions. These dimensions are then aggregated into the HEFW Index. While each of the three 'dimension' gets equal weightage in producing the final index score, the indicators within them also gets equal weightage. The Skill & Employability, Higher Education Quality & Participation and Research & Innovation each account for 1/3rd of the variation in final score. It is also worth cautioning that equal weightage does not imply no weightage. So, the inter-dimension as well as inter-indicator trade-off is constant throughout.

- *WEIGHT FOR CONSTRUCTING COMPOSITE INDEX FROM SUB-INDICES*

  $Weight_d$ = 1/3, where d =1,2,3

  Since, there are three dimensions or sub-indices – skill, higher education quality & participation and research and innovation

- WEIGHT FOR CONSTRUCTING SUB-INDICES FROM VARIOUS INDICATORS

  $Weight_i$= 1/n, where i (indicator)=1,2,3… n

  i.e., trade-offs between indicator x_i and x_j is assumed to be constant

4.3.6 Aggregation

There are three popular aggregation methods– additive aggregation, geometric aggregation and non-compensatory aggregation method. According to the OECD manual for indices, linear aggregation method is useful when all the indicators and dimensions have the same measurement unit. At the same time, other methods such as the Geometric aggregation are useful when the data is non-comparable. As such, the type of aggregation to choose is directly contingent on the method of normalisation. Since all the data have been normalised and can be expressed on the same interval scale, so linear aggregation method is best suited. By far the most widespread linear aggregation is the summation of weighted and normalised individual indicators. So, for the HEFW index, the weighted indicators are summed. It is also the most widely used and straightforward aggregation method. This popularity is also indicative of its reliability compared to other methods. Furthermore, *'linear aggregations reward base-indicators proportionally to the weights'* (Nardo et al., 2008). It is also worth noting here that all aggregation approach has some or the other biases which effect the final results. No CI is resistant to this challenge (Mayer, 2008).

4.3.7 Robustness

The OECD paper on indices (Nardo et al., 2008) argues that CI should be transparent (the rationale behind laying out the methodology and decision process in detail) and be fit enough to be decomposed to their principal indicators, i.e, from the CI, the real data should be traceable.

The benefit of using only 11 indicators is that it is narrow enough to comprehend how the index is derived. The source of data (all of which are government sources) also lends authenticity and reliability to the indicator. The three dimensions cover the three main aspects of future workforce requirements as well. Several studies have also suggested checking the robustness of the ranking generated by composite index generated vis-à-vis other alternative weights. However, there are no sufficient guidelines on which alternatives are better suited on a case-by-case basis (Seth & McGillivray, 2018). So, largely the assignment of weights and aggregation is consistent as per the literature on methodology of indices.

4.3.8 Summary

The step-by-step procedure explained how HEFWD is a CI with three sub-index and 11 dimensions to capture the complex phenomenon of existing state of Higher Education's potentiality in meeting the demands of future workforce requirements.

While table 4.3, encapsulates the methodology in a tabular form, the following equations express the Index construction in gist -

- *Skill for Employability Sub- Index*

$SEI_{GROUP\ A} = \frac{1}{n}\sum_{i=1}^{n}(Si)$= 1/5 *[CC'+SDC'+NMEICT'+TUE'+CBT']

$SEI_{GROUP\ B} = \frac{1}{n}\sum_{i=1}^{n}(Si)$= 1/4 *[CC'+SDC'+NMEICT' +CBT']

- *Research and Innovation Sub-Index*

RII = $\frac{1}{n}\sum_{i=1}^{n}(Ri)$ = 1/3*[IR'+NKN'+ARIIA']

- *Quality and Participation Sub-Index*

QPI $_{\text{GROUP A}} = \frac{1}{n}\sum_{i=1}^{n}(QPi)$= 1/3*[NAR'+ NAAC'+GER']

QPI $_{\text{GROUP B}} = \frac{1}{n}\sum_{i=1}^{n}(QPi)$= 1/2*[NAAC'+GER']

Finally,

- ***The Higher Education Future Workforce Composite Index***

HEFW = $\frac{1}{n}\sum_{i=1}^{n}(SIi)$

Where SI_i denotes each sub-Index

Table 4. 3- Summary of the HEFW Methodology

	Normalization	*Weighting*	*Aggregation for the three Sub-Indices*	*Composite Index (HEFW) Aggregation*
Higher Education Future Workforce Index	Min-Max Method	**w=[1/n(i)]** (where n(i) is the total number of indicators incorporated in the subindex	**= Σ $w_i x_i$**	**= 1/3 Σ [(SEI+ RII+ QPI)]**

4.4 Limitation

Data availability was the major constraint and conducting a new sample survey to gather data was beyond the scope of this paper, given the timeline and circumstances (with Covid 19 restrictions underway). In such a backdrop, a few compromises had to be made. The existing missing data in the incorporated dimensions are in the Net Access Ratio of the 'access and quality' dimension and 'assistance to universities for technical education' in the 'skill for employability' dimension. Despite some missing data in a few states, the 'net attendance ratio' was incorporated for calculating Group A scores because it indicates participation in HEI, which improves the robustness of the indices. Meanwhile, since 'assistance to universities in technical education' signals the priority of individual state government in improving its technical institutes, this also needed to be accounted for, and so has been included for Group A states only. For Group B states, both these indicators have been omitted.

In case of missing data, the conventional approach followed is case deletion or imputation. However, case deletion will unfavourably impact the robustness of the estimate. As per International Institute of Social Science (Foa & Tanner, 2012), the issue of missing data can be dealt in either of the three ways – the first approach is to drop the case (in this case, state) as this helps avoid methodological issues, or to drop the indicator if complete data does not exist. This was the rationale why the Union Territories have been excluded from the list as the issue of missing data plagued most of the UTs. Even numerous indicators were dropped and the resultant indicator list although narrow, but is immune from this missing data challenge. The second approach is to impute missing values, but it has shortcomings of unreliable imputation and legitimacy. The third approach, which was utilised in HEFW index was to use the existing data in entirety, which could lead to an 'estimated margin of error' dependent on the number of missing terms. The estimated margin of error is minimal here because the data for NAR is missing for a few states only (the implication of this is elaborated in the next chapter where the findings are discussed in detail).

In case the HEFW is updated at a periodic interval, then a caution also needs to be maintained that the addition of new indicators in the subsequent version can decrease or increase the final index value without fundamentally changing the state of affairs. As careful approach needs to be adopted to discount this phenomenon, in case the index is further improved and contrasted inter-temporally.

CHAPTER 5

HIGHER EDUCATION FUTURE WORKFORCE POTENTIAL OF INDIAN STATES

5.1 Higher Education Future Workforce (HEFW) Composite Index and its three constituent (Sub) Indices

The previous chapters have established the three critical pillars of realising HEI's future workforce potential. These include – firstly, the skill and employability pillar; secondly, the research and innovation pillar, and finally, the quality and participation pillar. Since each pillar represents a specific dimension of higher education's contribution to workforce development, the composite indicator derived from the summation of the three provides a holistic overview of higher education's potential of meeting future workforce requirements.

Furthermore, each pillar is also a sub-index of sorts, as the calculation involves aggregating indicators unique to each dimension. The list of three pillars or sub-indices and the respective record of its indicators are outlined in Fig.5.1.

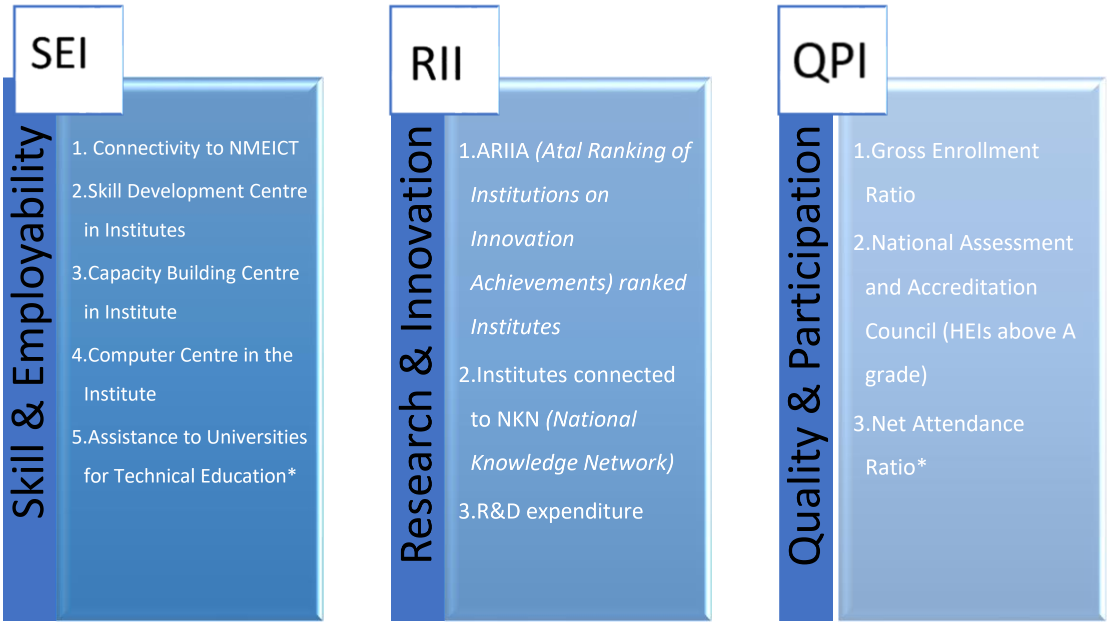

Fig. 5. 1-The Indicators included in each Individual (Sub) Indices

5.2 Basis of Classification of States

A country as large as India has a lot of heterogeneity within its states, characterized by a variation in demographic structure, topography, resource base, income level, ability to mobilise resource for development etc. As such, there are specific geographical regions that have been historically neglected and consequently, have been lagging in most developmental parameters. The disadvantage of these states arises from numerous factors such as their spatial location including factors such as hilly terrains, strategic international borders etc. Given such inherent disparities, it unlikely that comparing all the states and treating them alike would yield any meaningful result. Without spatial segregation, introducing the index would lead to complexities as some states are favourably positioned to invest, entail greater public expenditure and have better state capacity. Therefore, to ensure fair comparability among states, they have been bifurcated into – Group A (Normal states) and Group B (Special Category states). Union Territories have not been incorporated as there was an issue of data availability for the majority of the parameters. The state of Jammu and Kashmir has been retained in Group B states. This is because the time period for the data collected for most of the parameters was before its conversion to a UT. Thus, the existing J&K and Ladakh cumulatively represent the state of Jammu & Kashmir in this paper. Likewise, Andhra Pradesh is representative of the present-day state of Telangana and Andhra Pradesh.

Table 5. 1- Groupwise Categorisation of States

Group A States (Normal States)	Andhra Pradesh, Bihar, Chhattisgarh, Delhi, Goa, Gujarat, Haryana, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Odisha, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal
Group B States (Special Category States)	Arunachal Pradesh, Assam, Himachal Pradesh, Jammu & Kashmir, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura, Uttarakhand

This categorisation of states is not novel per se. In the past, the Planning Commission had employed this categorisation which continues till data with regards to certain policy areas such as funding of Centrally Sponsored Schemes where in case of Special Category States, the Central government pays 90% of the fund compared to 60% in Normal Category States. Such a categorisation seeks to provide preferential treatment these underdeveloped states. Accordingly, a similar approach for index creation is adopted wherein some indicators are dropped for Group B states, given the absence data in majority of the states owing to lack of the infrastructure, implementation of policies, maintaining records etc.

5.3 Analysis of each Sub-Indices Score and its respective Indicator

The following section analyses the scores of each of the sub-indices – skill and employability, research and innovation, and, quality and participation. It furthers examines each indicator incorporated in calculating the (sub) index and eventually, the composite index. Since the indicators included for the analysis of a given dimension/ sub-index vary based on whether it is a Normal State or a Special Category State, the group's analysis is conducted in silos to ensure equitable comparison.

5.3.1 SKILL AND EMPLOYABILITY (SUB) INDEX

5.3.1.1. Group A States (Normal States)

5.3.1.1.1 Analysis of Indicators incorporated in the Group A SEI Score Calculation

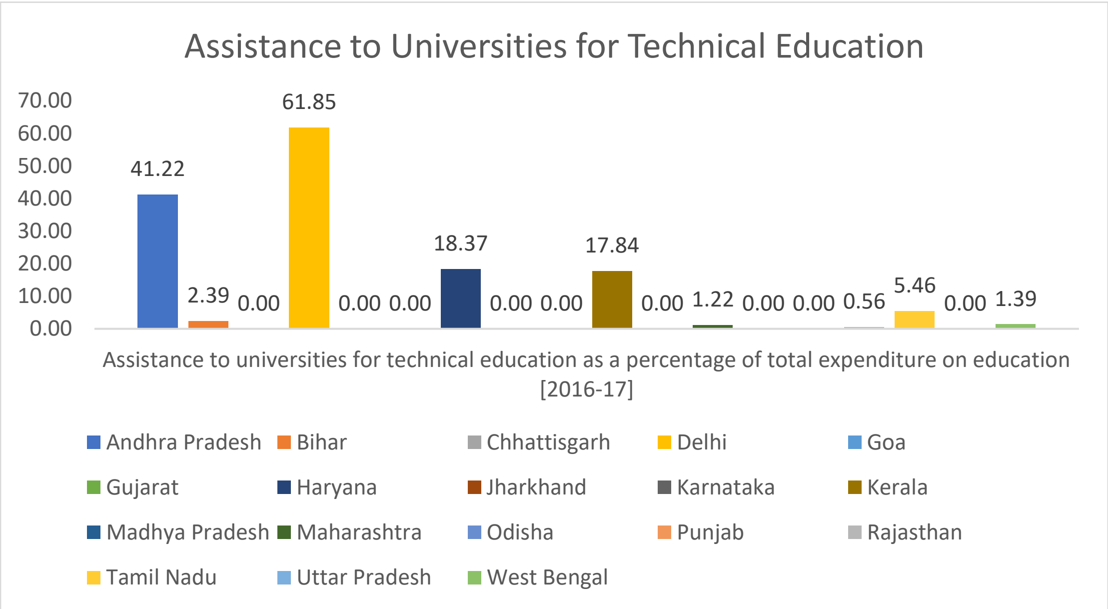

Fig. 5. 2-Assistance to Universities for technical education (Group A States)

Since technical skills are a core future skill requirement, we use this input measure of assistance provided to universities for technical education as a percentage of total expenditure on education. To realize how much each state spends on technical education as a proportion of total expenditure on education. From Fig.5.2, it can be observed how most of the states spend negligible amount on technical education, with the universities of nine states receiving no assistance whatsoever. Such a dismal condition has only aggravated the disparity. The highest expenditure dedicated to technical education as a proportion of its total education expenditure is Delhi at 61.85%. Andhra Pradesh comes close second with 41.2%. Meanwhile, universities of other states like Chhattisgarh, Jharkhand, Gujarat, Goa, Punjab, Odisha etc. have not been provided any assistance. Although universities can still spend on education despite any assistance, the magnitude is bound to be limited. Financial assistance from the government further signals policy priority which is clearly lacking for most of the states here.

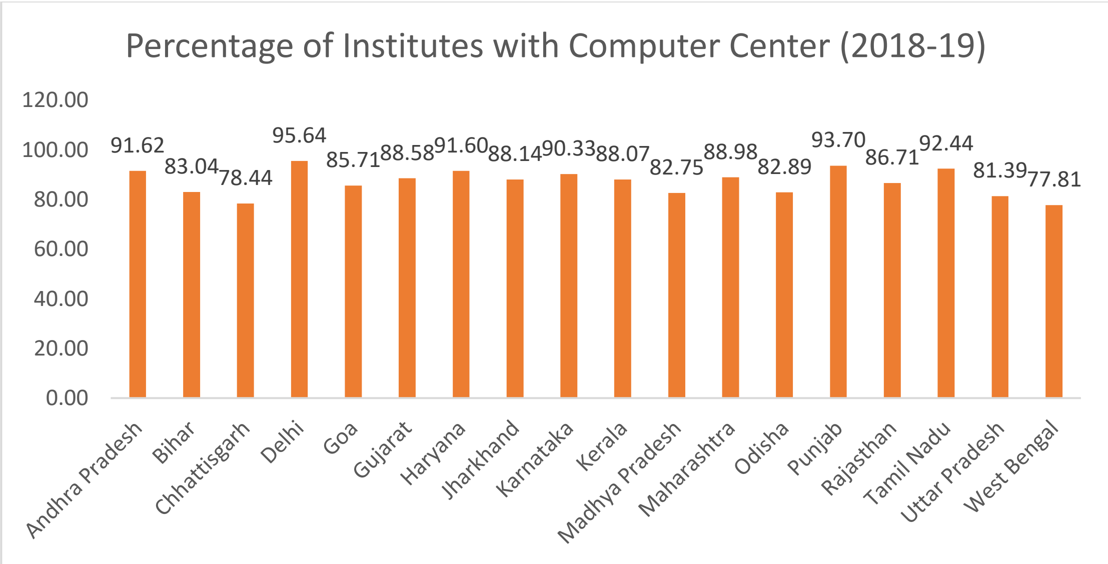

Fig. 5. 3-Percentage of Institutes with Computer Centre (Group A States). Calculated from AISHE 2018-19 data

Despite the spread of internet connectivity across India, the spike in internet adoption is mediated by mobile phones and now computers. This is somewhat obvious given the fact that smart phones are cheaper vis-à-vis personal computers and laptops. So is mobile data, with India's mobile data priced the lowest in the world. As such, ownership of computers or laptops is a luxury, which the majority of the students can ill-afford. It is thus natural that most students rely heavily on computer centers to use software which is not compatible with a mobile or tablet. Even for general information surfing purposes, using software and gaining familiarity with computers, computer centres are crucial in HEIs. A positive aspect is, as can be seen from Figure 5.3, an overwhelming majority of institutes are endowed with computer centres. An average of 87% of institutes has computer centres. In terms of variability, Delhi ranks the highest with 95.64% of its institutes endowed with computer canters while the most backward state is West Bengal at 77.81%.

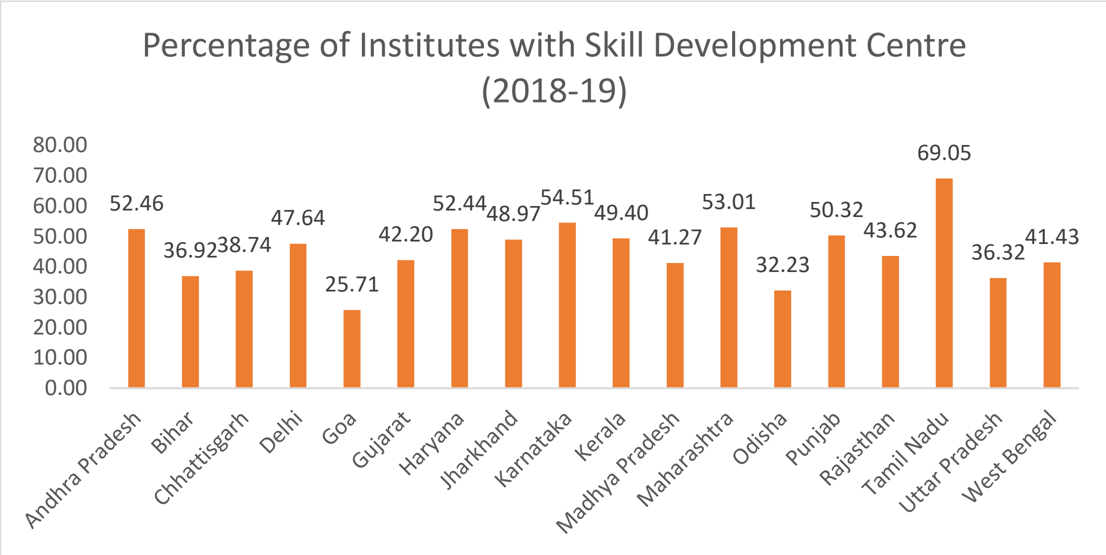

Fig. 5. 4-Percentage of Institutes with Skill Development Centre (Group A States). Calculated from AISHE 2018-19 data

The presence of a Skill Development Centre in an HEI indicates the importance warranted to skilling its students. With ever-widening skill gap in the country, the existence of a skill development centre ensures that students have the choice of developing their skill-set and improve their employability potential. Despite its relevance, the situation appears to be grim as an average of only 45.35% of HEIs house such centres. It is apparent from Figure 5.4 that Tamil Nadu followed by Karnataka are the leaders at 69% and 54%, while Goa ranks the lowest at 25.71%.

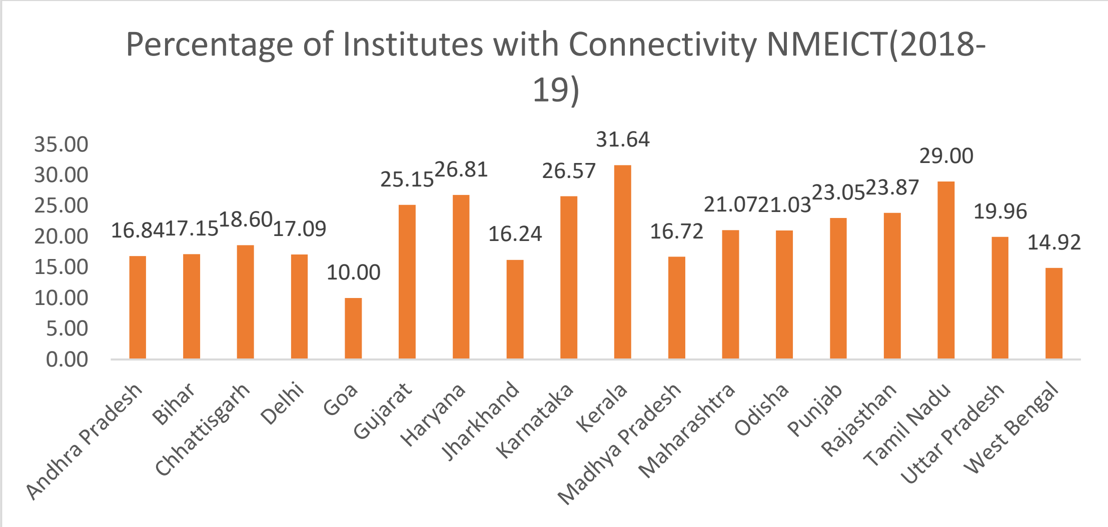

Fig. 5. 5-Percentage of Institutes with NMEICT connectivity (Group A States)

The National Mission on Education through Information and Communication Technology (NMEICT) is a Centrally Sponsored Scheme to harness the potential of ICT for teaching and learning in HEIs. Programs such as SWAYAM, National Digital Library of India, Free and Open-Source software for Education, spoken tutorial (to improve student employability), E-Yantras and Virtual Lab and others come under the ambit of NMEICT. Consequently, connectivity to NMEICT is a clear indicator of facilities developing both communication and ICT competencies. Analysing Figure 5.5, it can be observed that an average of only 20% of institutes are connected to NMEICT. Kerala and Tamil Nadu have the highest proportion of universities connected to NMEICT at 31% and 29%. Goa, with at 10%, ranks the lowest among the given states.

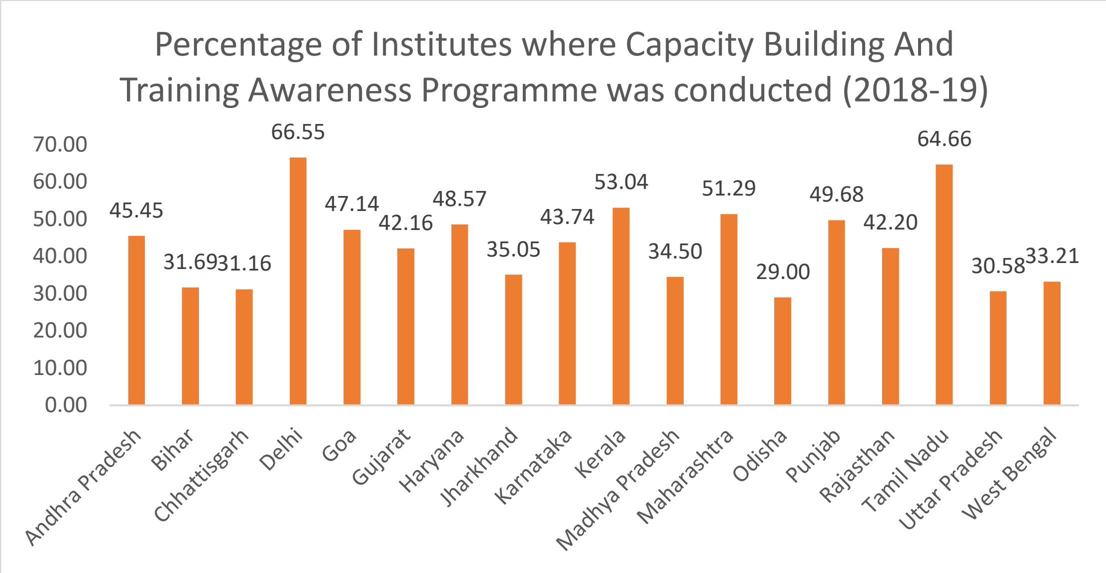

Fig. 5. 6-Percentage of Institutes with Capacity Building and Training Awareness Programme (Group A)

The National Employability Report of 2019, stressed how 'lack of counselling and direction' was a significant obstacle for students finding a suitable job. Counselling, capacity building and training programmes enables students to address their skill gaps. Such programs, while helping students assess their capabilities, enable students to identify better company matches and prepare for interviews. As such, while the benefits accruing from conducting such programs is large, on an average 43% of the institutes in states conduct them. From Figure 5.6, Delhi followed closely by Tamil Nadu, are the leaders of the pack at 66.55% and 64.66% of the total institutes conducting such programs, respectively. Meanwhile, Odisha with only 29% institutes conducting such programs rank the lowest at 29% as can be seen from Fig.5.6.

1.1.1.1 Analysis of Group A SEI Scores

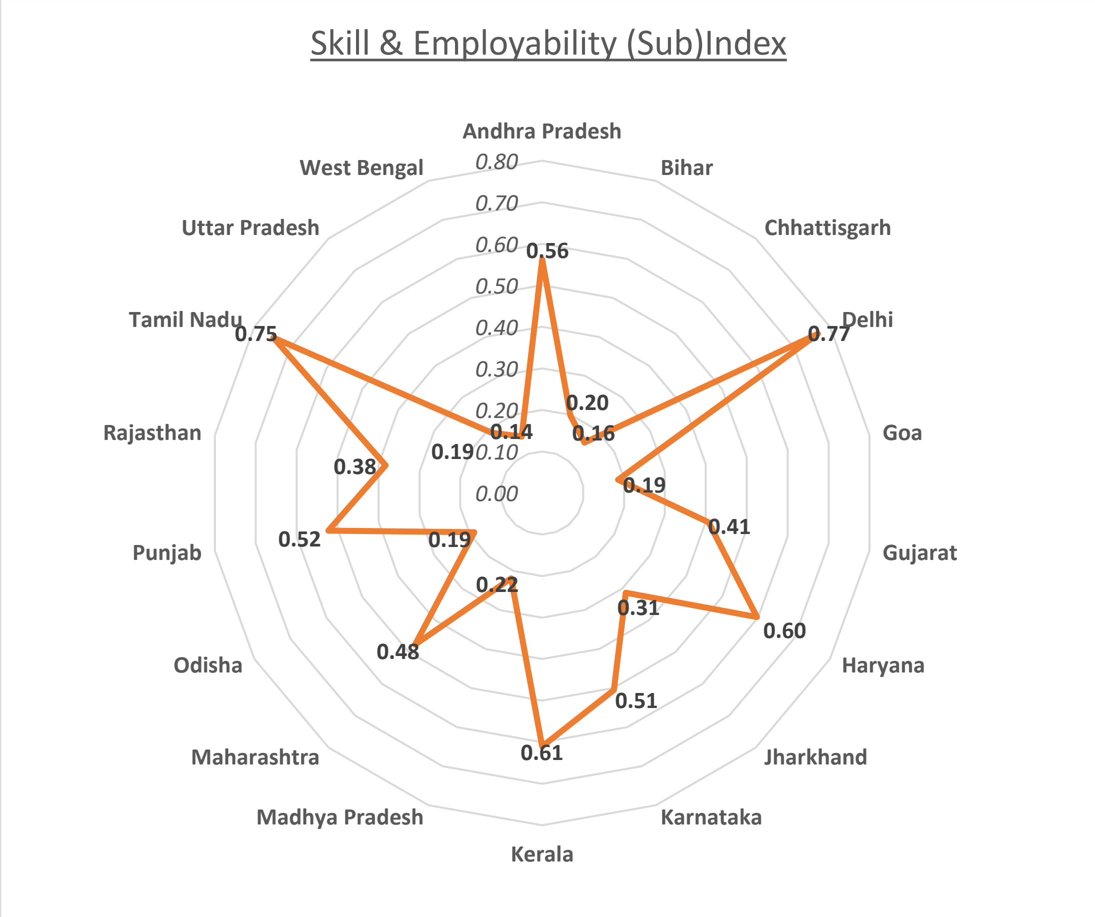

Fig. 5. 7 - Skill and Employability (Sub) Index - Group A States

Overall, the Sub-Index of Skill and Employability is indicative of the state's comparative performance in skilling and improving the employability potential of the students enrolled in HEIs. The results, which range between 0 and 1, specify the relative performance in concrete terms - a value closer to unity showing better performance and closer to 0 indicating substandard performance. The results obtained are also largely consistent with the trend of the national skills report showing that input factors such as the indicators incorporated have direct bearing on student's skill and employability levels. As can be seen from Figure 7, Delhi tops the chart with a score of 0.77, followed closely by Tamil Nadu with a score of 0.75. Kerala at 0.61 and Haryana at 0.60 are similarly placed- given their relative performance, they are also among the top scoring states. The lowest-scoring states is West Bengal at 0.14, Chhattisgarh at 0.16 and Uttar Pradesh at 0.17.

1.1.2 Group B States (Special Category)

1.1.2.1 Analysis of Indicators incorporated in the Group A SEI Score Calculation

For the Special Category states, data on Assistance for Technical Education for students was missing for an overwhelming majority of the states, which methodologically could lead to a distorted score. To ensure robustness of the indicator and reduce the error arising for the additional weightage given to a couple of states with data on technical education expenditure, this indicator incorporated for Group A states, is omitted for Group B states. The other indicators have been retained as the missing data issue was not as pervasive. The following paragraphs lays out the analysis of the Group B SEI scores and indicators incorporated for its calculation.

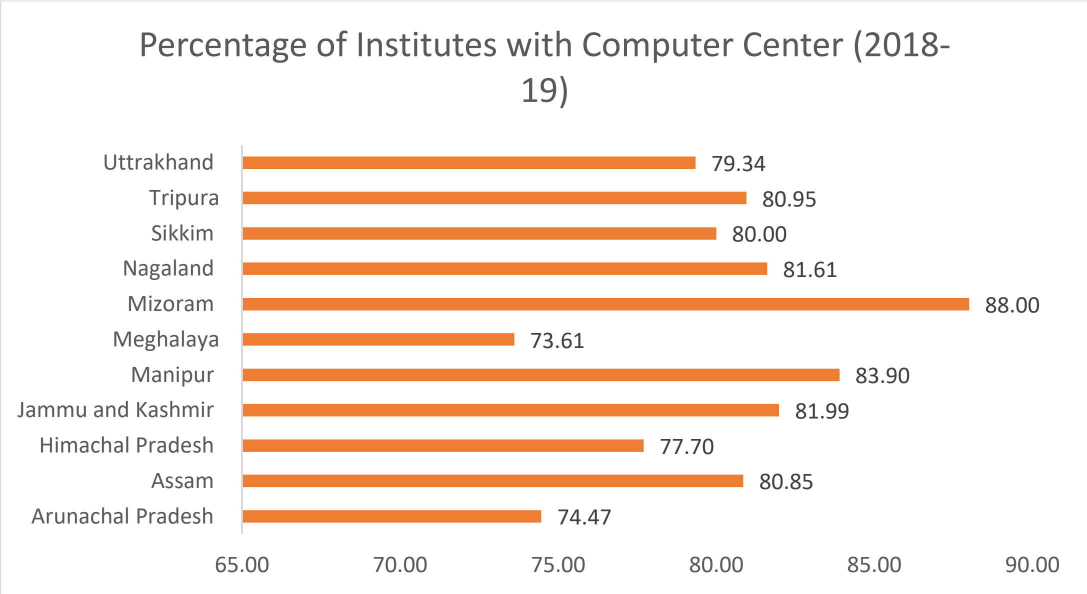

Fig. 5. 8 - Percentage of Institutes with Computer Centres (Group B)

As Figure 8 reveals, for the Special Category states, Mizoram has the largest proportion of institutes with Computer Centres at 88%, while Meghalaya has the lowest at 73%. Nevertheless, the encouraging factor remains that the overall performance for this indicator is steady, as is evident from the group average of 80.22 %.

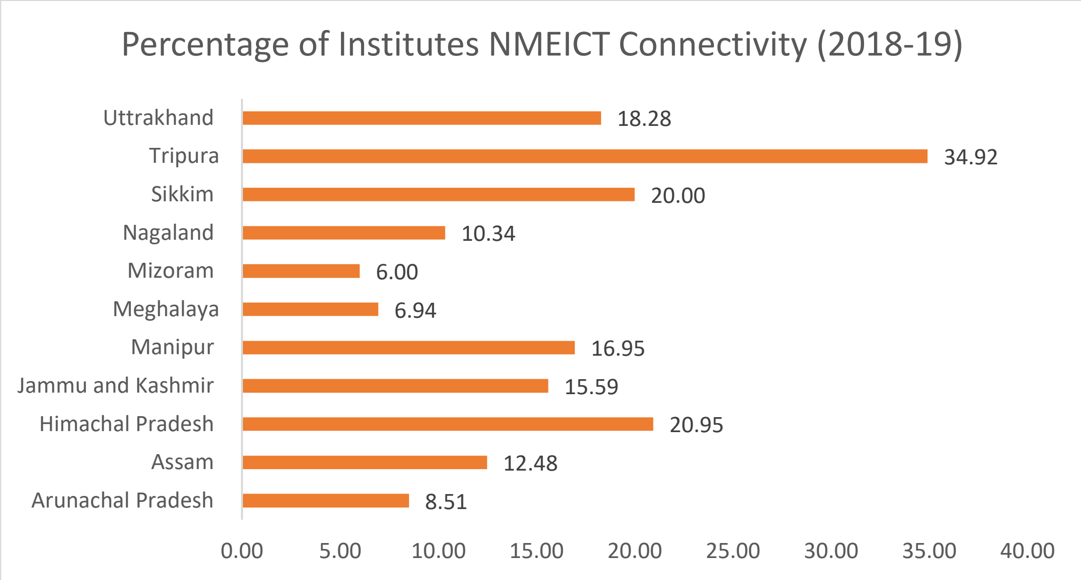

Fig. 5. 9 - Percentage of Institutes with NMEICT Connectivity (Group B)

With regards to NMEICT connectivity in the HEIs, Group B states are in a deplorable state. With an average of only 15% institutes connected to NMEICT across states, the trend is particularly worrisome given that special category states can benefit immensely from this Centrally Sponsored Scheme. Even Tripura, as the highest-ranking state in this context has an appalling 34.92% HEIs covered under the scheme. Mizoram at 6% is the lowest ranked state as can be seen from Figure 9. The overall abysmal rate of the scheme's distribution especially in the special category states suggests the neglect in incorporating these states under the purview of NMEICT, and necessitates further scrutiny, as it is beyond the scope of this paper.

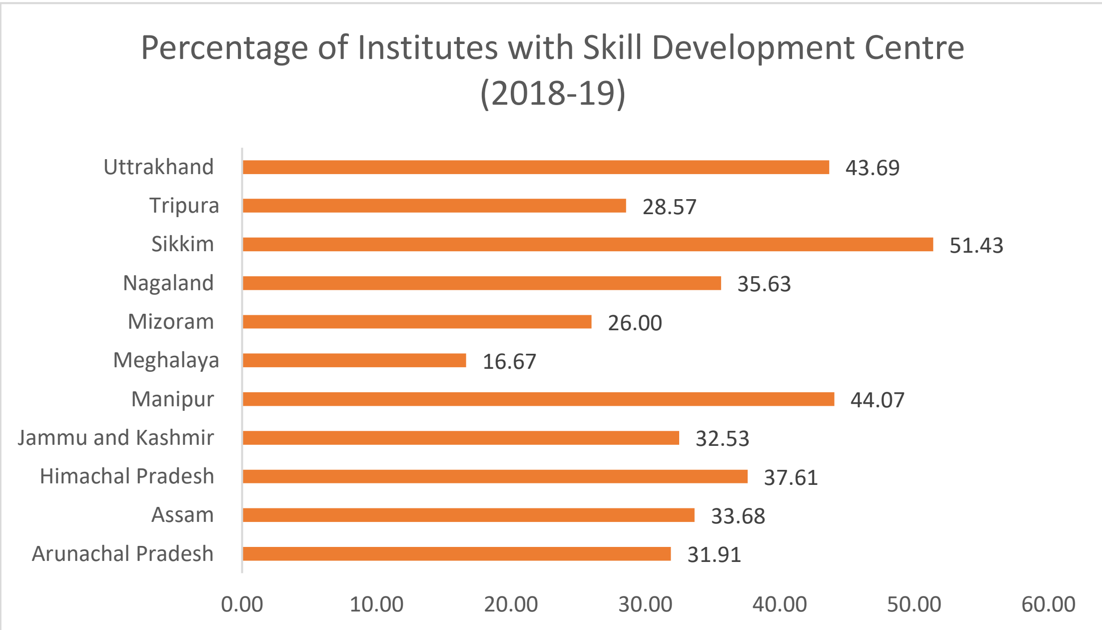

Fig. 5. 10 - Percentage of Institutes with Skill Development Centre (Group B)

The performance for the indicator 'Skill Development Centre' is not particularly encouraging either. Across all the states, an average of only 34.71% of all the institutes has such centres. The disparity is equally striking with institutes in Sikkim housing the highest percentage of such centres at 51.43% and the lowest is at Meghalaya with 16.67%. The state-wise measures are illustrated in Figure 10.

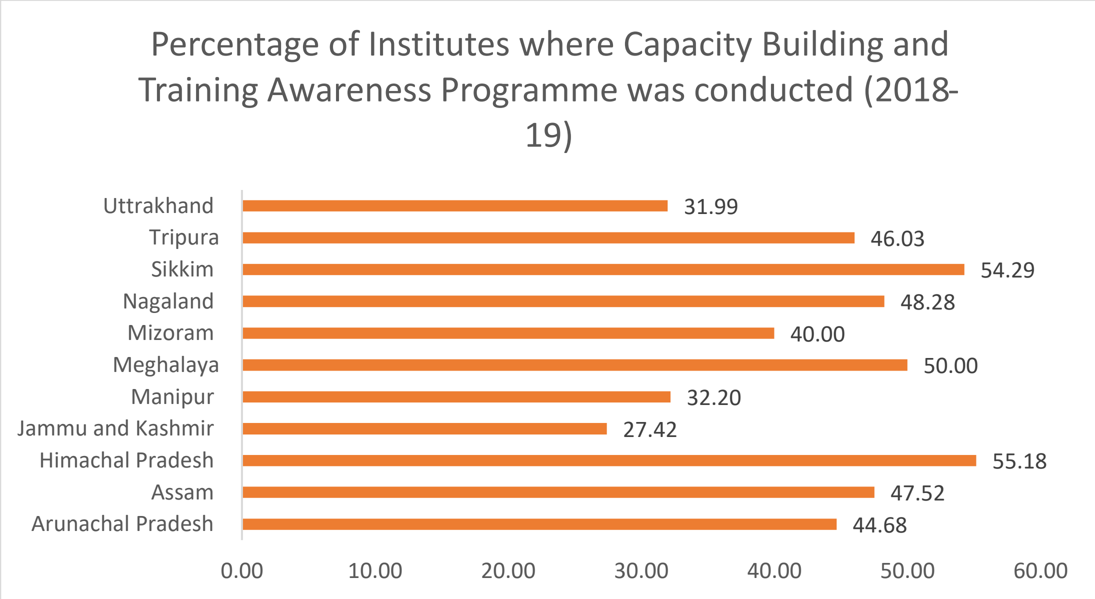

Fig. 5. 11 - Percentage of Institutes with Capacity and Training Awareness Programme (Group B)

In terms of institutes that provided capacity building and training programme, as can be seen from Figure 11, Himachal Pradesh fared the best at 55.18% followed closely by Sikkim at 54.29%. Overall, the aggregate average of the states stands at 43.42%. This implies that there is significant room for improvement as less than half of the institutes conduct such programmes.

5.3.1.1.2Analysis of Group B SEI Scores

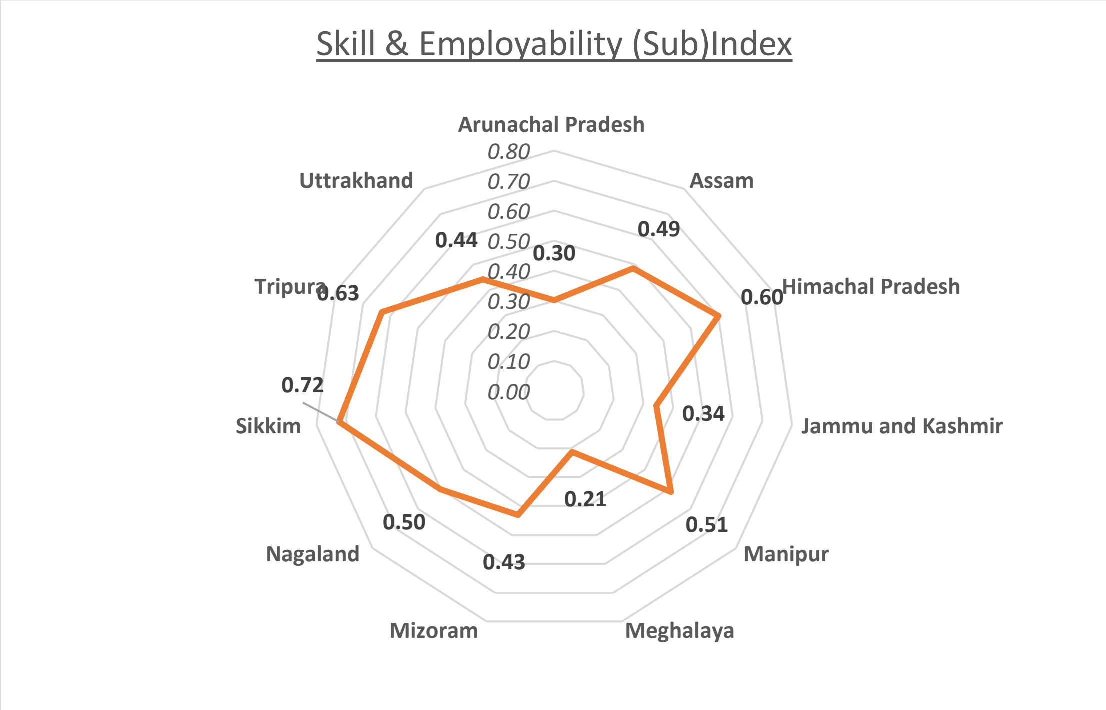

Fig. 5. 12-Skill and Employability (Sub) Index - Group B States

As can be observed from Fig.5.7., the top performers in this category are Sikkim with a score of 0.72, followed by Tripura with a score of 0.63 and Himachal Pradesh with a score of 0.60. The lowest performing states include Meghalaya with a score of 0.21, followed by Arunachal Pradesh at 0.30 and Jammu and Kashmir with a score of 0.34. The inter-state divergence in scores among special category states is indicative of the lost potential of the state's HEIs in developing the skill and employability level of the students enrolled.

5.3.2 RESEARCH & INNOVATION (SUB) INDEX

5.3.2.1 Group A States (Normal States)

5.3.2.1.1Analysis of Indicators incorporated in the Group A RII Score Calculation

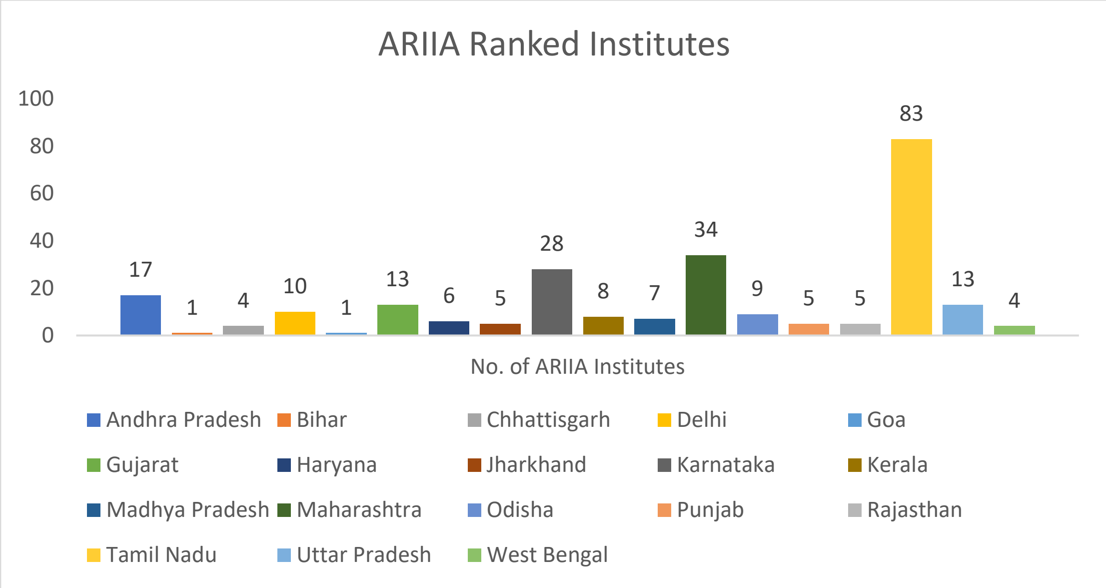

Fig. 5. 13-State wise number of Institutes included in ARIIA ranked list (Group A)

Atal Ranking of Institutions on Innovation Achievements (ARIIA) 2020 is a recent initiative of the Ministry of Education to rank HEIs on indicators corresponding to 'Innovation and Entrepreneurship Development'. As such, this indicator is reflective of the quality of institutes capable of undertaking innovation. It includes publicly funded and privately funded institutes. The indicators used in the ranking encompass themes from budgetary support to Intellectual Property to innovation and learning methods in the courses taught. Given the strict quality measure taken into consideration for the maiden 2020 awards, Fig.5.8. lists the number of institutes from a given state which appeared in the top 50 rankings (in various sub-categories). As can be seen from the figure, the disparity is immense, with Tamil Nadu topping the list at 89 institutes, with Maharashtra coming close second at 34 institutes. On the other end of the spectrum, Goa has only one institute which made it to the list, namely- Goa University.

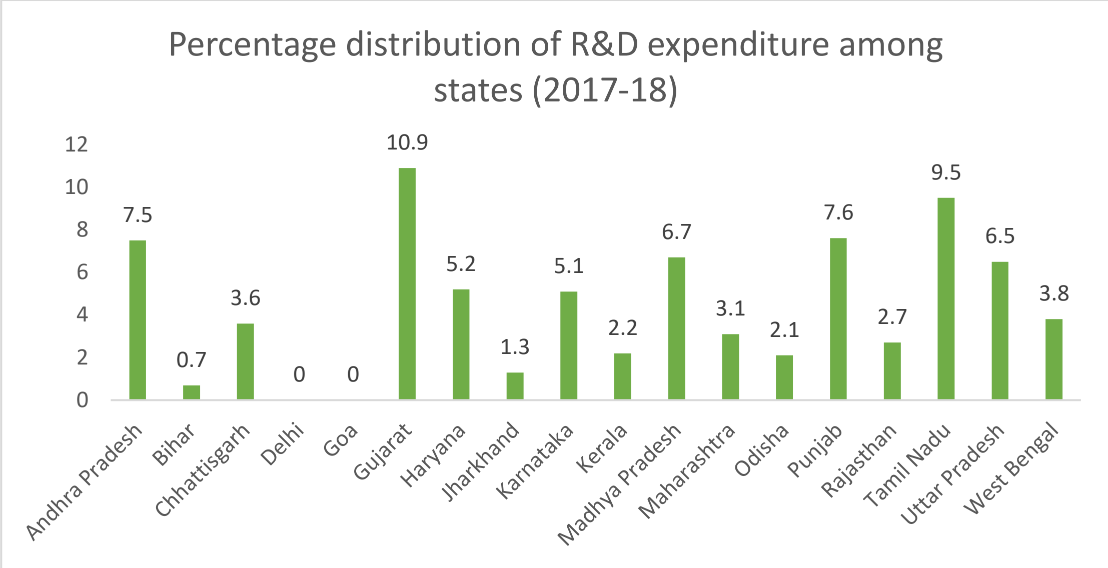

Fig. 5. 14-Percentage distribution of R&D expenditures among states (Group A)

The percentage of R&D expenditure by states accounts for close to 6.4% of the national R&D expenditure(Dept of Sci & Tech, 2020). The values show the contribution of each state as a percentage of the total contribution. In this data set, however, there is an issue of missing data for the states of Delhi and Goa. Given the relevance of this indicator in revealing state-wise priority designated to research and the data availability for most states, the indicator has been included. The limitation of missing data necessitates a mindful reading of the final indicator, although the other indicators of the dimension can compensate for the dearth of one indicator. A quick look at Figure 14 shows that only a few states cumulatively account for over 55% of the total R&D expenditure of the states. These states include – Gujarat, Tamil Nadu, Punjab, Andhra Pradesh, Madhya Pradesh, Uttar Pradesh, and Assam, in the order of magnitude. Among the states where data is available. Among the remaining sates, Bihar ranks the lowest at 0.7%.

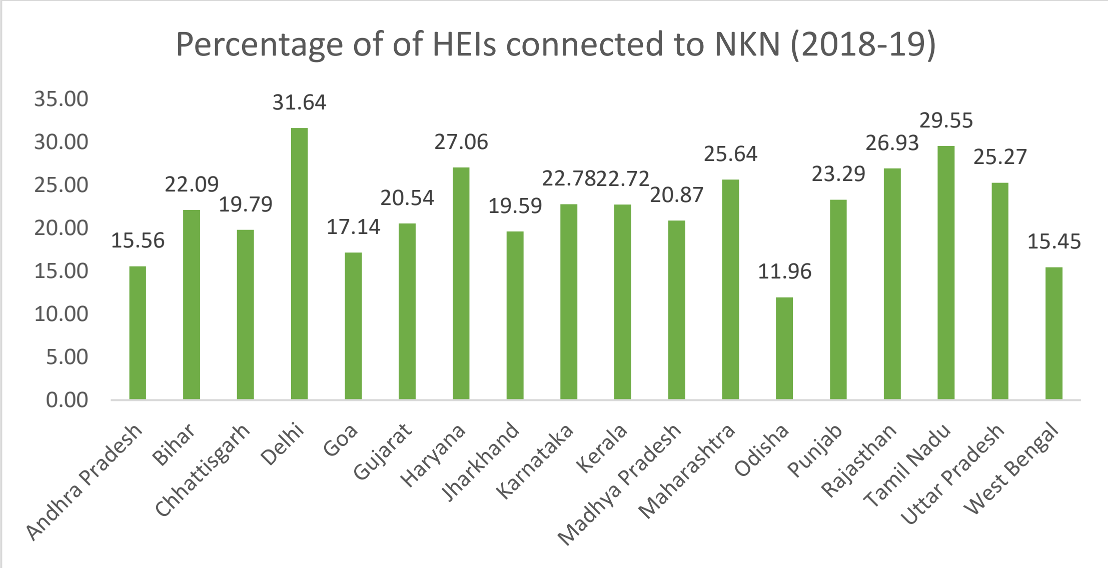

Fig. 5. 15-Percentage of HEIs connected to NKN (Group A)

National Knowledge Network (NKN) is a national research and educational network which provides unified high-speed network in educational institutes. Managed by the National Information centre, connectivity to NKN enables advanced application in areas of grid computing, science and technology, health, education, bioinformatics etc. As highlighted in NKN's website "*by facilitating the flow of information and knowledge, the network addresses the critical issue of access and creates a new paradigm of collaboration to enrich the research efforts in the country*". As such, the network integrates with the global scientific community at a superior speed and fosters collaborative research. From Figure 5.10, it can be observed that the overall level of NKN connectivity across states is disappointing. While Delhi, Tamil Nadu and Haryana are the top performers with 31.64%, 29.55% and 27.06% of its HEIs connected to NKN. The status of Odisha and West Bengal is bleak with only 11.05% and 15.45% of the state's institute connected to the network. For all the Group A states, an average of 22.1% institutes are connected – way below the halfway mark.

5.3.2.1.2Analysis of Group A RII score

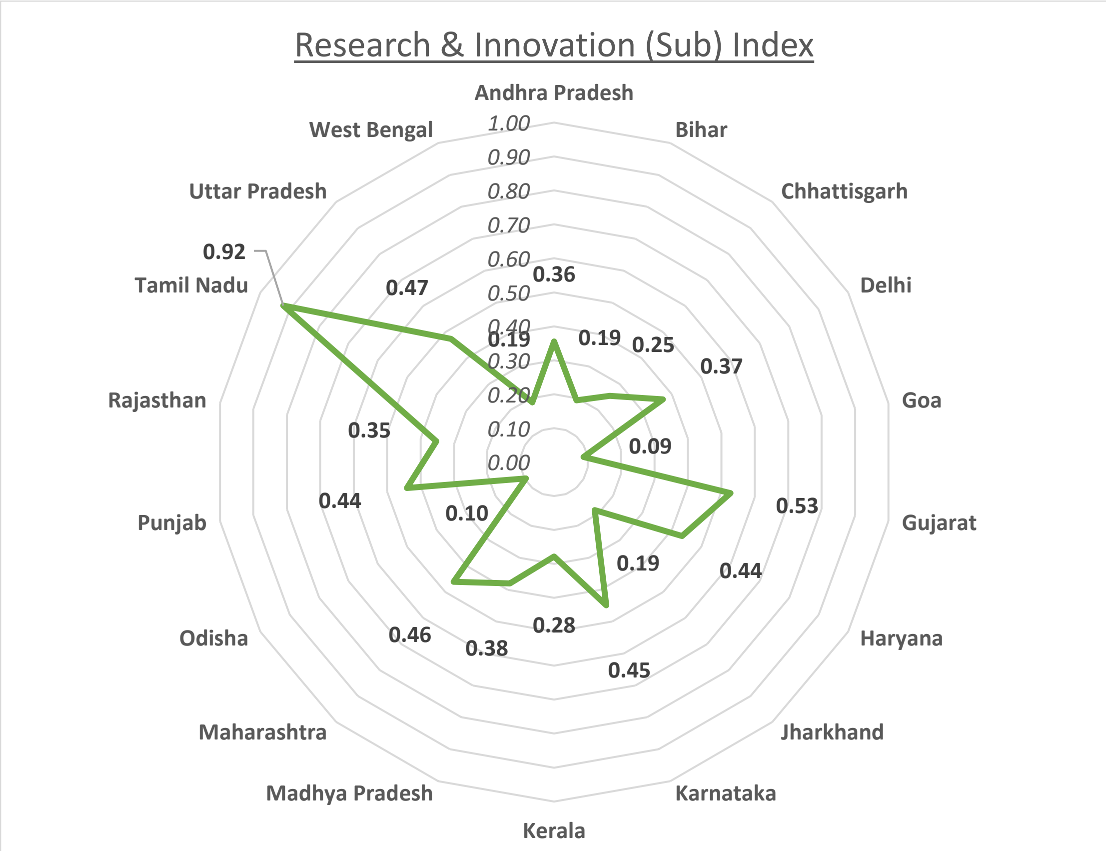

Fig. 5. 16-Research & Innovation (Sub) Index - Group A States

Fig.5.11, detailing the score of the Research & Innovation (sub) index demonstrates the acute imbalance. Even after accounting for data unavailability for R&D expenditure for Delhi and Goa, the disparity is apparent. The state of Tamil Nadu with a score of 0.92 is an obvious exception in the midst of all other Group A states, who have clearly underperformed by a significant margin. Barring Goa with a score of 0.9, all other low performing states are the usual suspects- Odisha, Jharkhand and Bihar. With an average score of 0.35, Indian states are lagging behind in capitalizing on its intramural R&D potential. This is a major obstruction in India's capability to partake the benefit of knowledge economy, whose foundations are based on knowledge production and innovation.

5.3.2.2 Group B States (Special Category States)

5.3.2.2.1Analysis of Indicators incorporated in the Group A RII Score Calculation

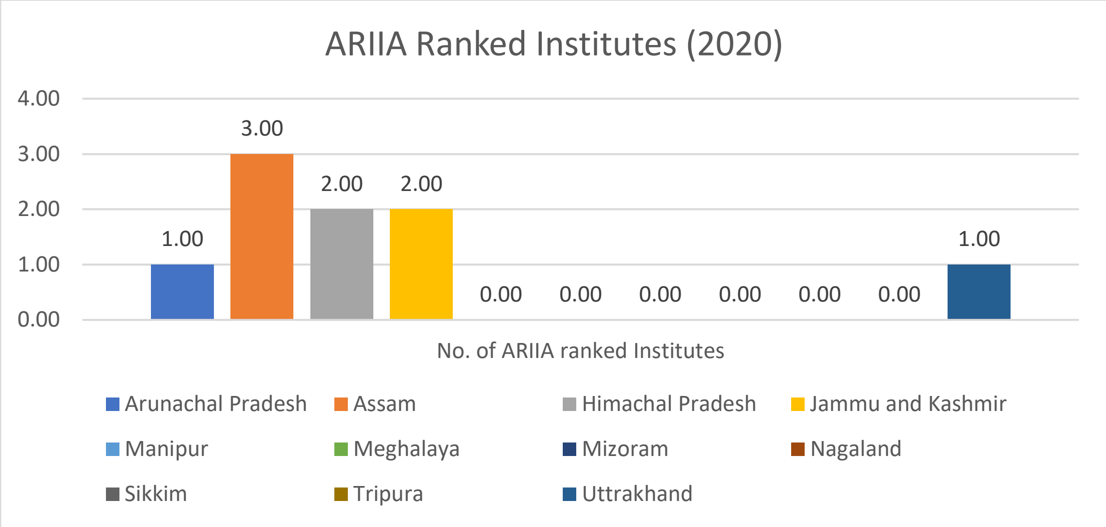

Fig. 5. 17-ARIIA Ranked Institutes (Group B)

In case of Group B states, very few have institutions have made it to the list of top fifty ranked institutes in different category. As can be seen from Fig.5.12, Assam with 3 institutes has the highest number of institutes in the list. Parallelly, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura have no institutes which made it to the list. Since the ARIIA rankings and its various sub-categories is dedicated to research and innovation, the overall average of less than one institute per states suggests that majority of the Group B states are faring poorly in this domain.

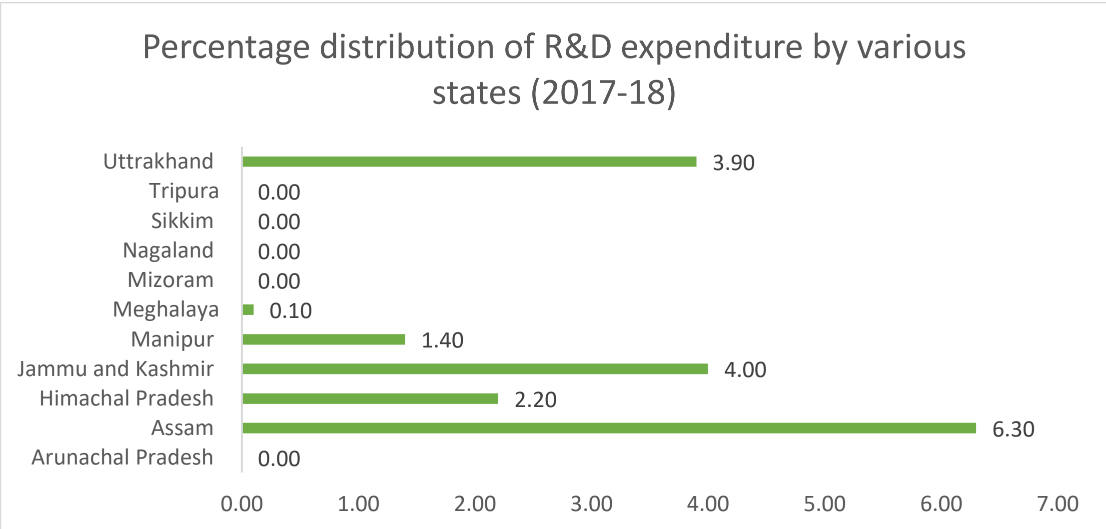

Fig. 5. 18-Percentage distribution of R&D expenditure by various states (Group B)

With regards to distribution of R&D expenditure, the results again are largely consistent with the results of the ARIIA rankings. Notwithstanding, the distressingly inadequate expenditure in R&D at 0.83%, performance of states like Assam (6.3%), Jammu & Kashmir (4%) and Uttarakhand (3.9%) has superseded the expenditure of many Group A states. This is illustrated in Fig.5.13. Manipur (1.4%) and Himachal Pradesh (2.2%) can be considered to be mid ranking states. At the end of the spectrum, Tripura, Sikkim, Nagaland, Mizoram and Meghalaya rank lowest with their expenditure hovering close to 0.

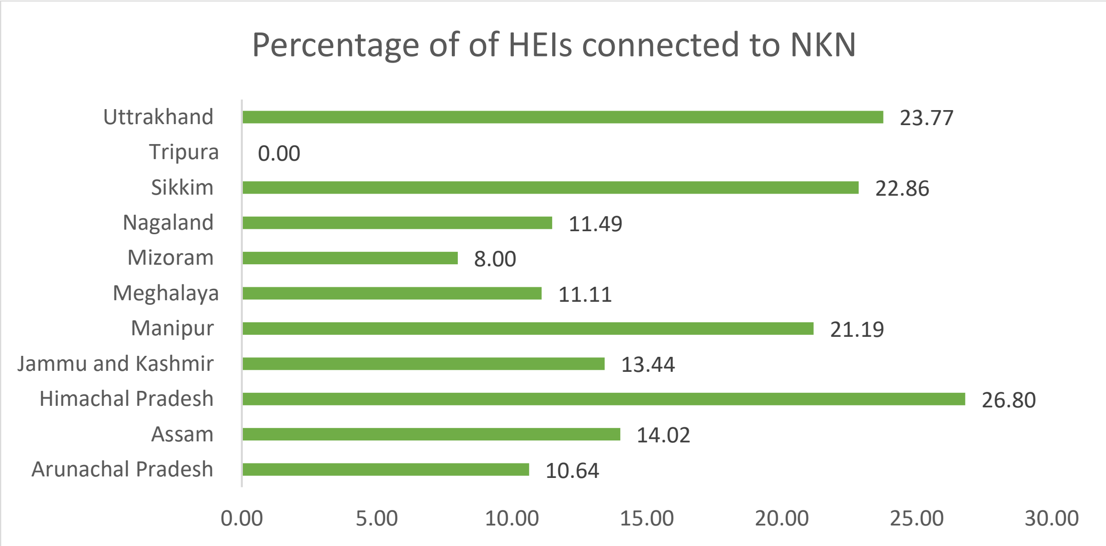

Fig. 5. 19-Percentage of HEIs connected to NKN (Group B)

Relative to the other two indicators, the performance of states in terms of HEIs connectivity to NKN is somewhat encouraging with a group average of 14.85%. The leaders of the pack are Himachal Pradesh (26.80%), Uttarakhand (23.77%), Sikkim (22.86%) and Manipur (21.19%). Meanwhile, as can be observed from Fig.5.14, Tripura is the lowest ranked state with no institutes connected to NKN.

5.3.2.2.2Analysis of Group B RII score

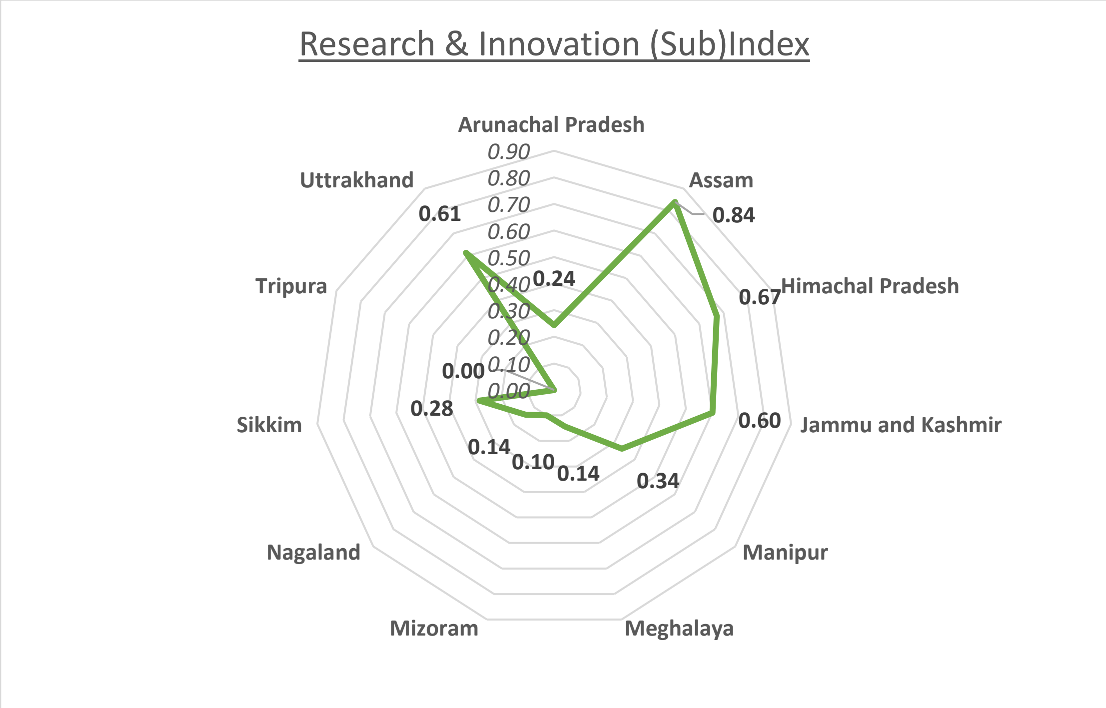

Fig. 5. 20-Research & Innovation (Sub) Index - Group B States

The RII score of Group B states indicates huge disparity, as can be observed from Fig.5.15. While Assam with a score of 0.84 ranks the highest, Tripura has a score of 0 specifying how its performance with regards to research and innovation in the Higher Education space is yet to take off. Himachal Pradesh (0.67), Uttarakhand (0.61) and Jammu and Kashmir (0.60) are among the mid scoring states. Another observation which can be extrapolated is the bleak performance of all north eastern states with the exception of Assam. The RII scores calls to attention the need for prioritizing research as a core part of HEIs.

5.3.3 QUALITY AND PARTICIPATION (SUB) INDEX

5.3.3.1 Group A States (Normal States)

5.3.3.1.1Analysis of Indicators incorporated in the Group A QPI Score Calculation

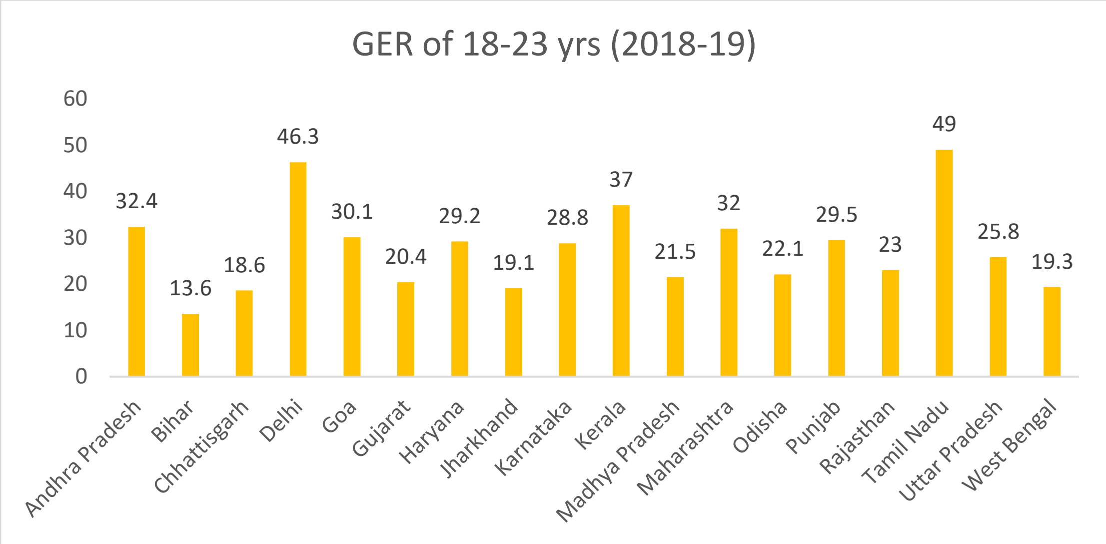

Fig. 5. 21-GER of 18-23yrs (Group A)

GER provides a broad idea about the coverage of the proportion of 18 to 23 years who are enrolled in higher education. The age group of 18 to 13 years was selected because traditionally a large majority of students from this age group are enrolled. From Fig.5.16, it can be observed that Tamil Nadu has the higher proportion of students enrolled with a GER of 49. This is followed closely by Delhi at 46. The lowest enrolment is in Bihar (13.6). Broadly, at an all-India level, southern states have performed considerably better than other regions, especially eastern states, which ranks the lowest in hierarchy. With an aggregate GER of 27.6, the youth's participation is stunted and is in dire need of expanding, if the youth's full potential needs to be realised.

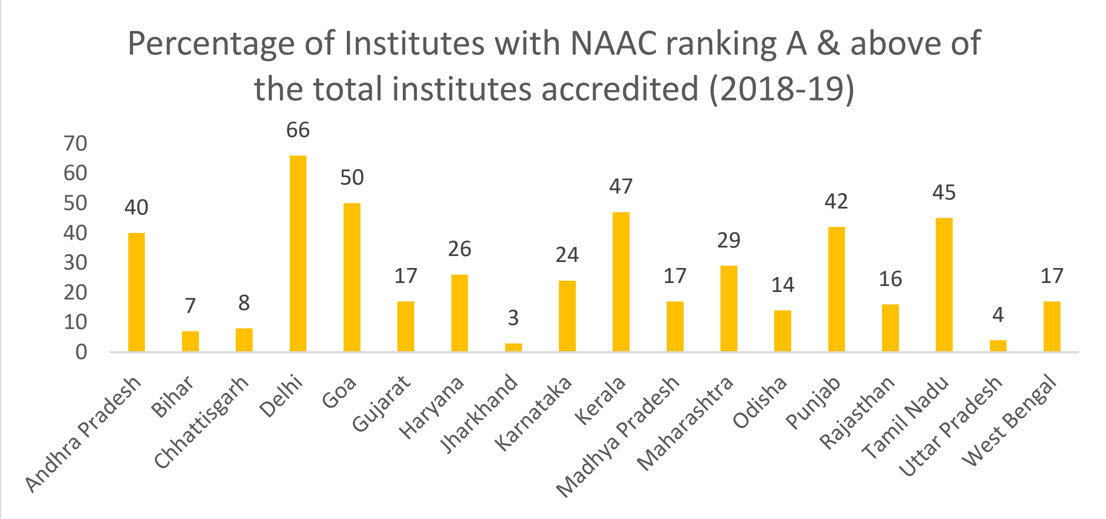

Fig. 5. 22-Percentage of Institutes with NAAC ranking A and above (Group A)

Since most of the quantitative enrolment indicators remain silent about the quality of the higher education institutes, the National Assessment and Accreditation Council (NAAC) rating was incorporated despite claims of 'subjectivity' in its evaluation. Through its eight-grade ladder (A++, A+, A, B+, B, C, D) it ranks institutes based on different parameters denoting 'quality'. From the list of ranked institutes in the states, only institutes with ranks A and above were included to arrive at the percentage. The results are evident from Fig.5.17, which shows how Delhi with 66% of its institutes with rank A and above, ranks the highest in terms of quality of HEIs. Yet again, the southern states of Kerala (47%), Tamil Nadu (45%), Andhra Pradesh (40%) are among the better ranked states. In the lower end of the spectrum, HEIs of Jharkhand (3%), Uttar Pradesh (4%) and Bihar (7%) are worse off. Overall, a combined average of only 26.2% institutes ranked A and above in Normal states is a cause of alarm, given how it insinuates a major proportion of HEIs are of substandard quality.

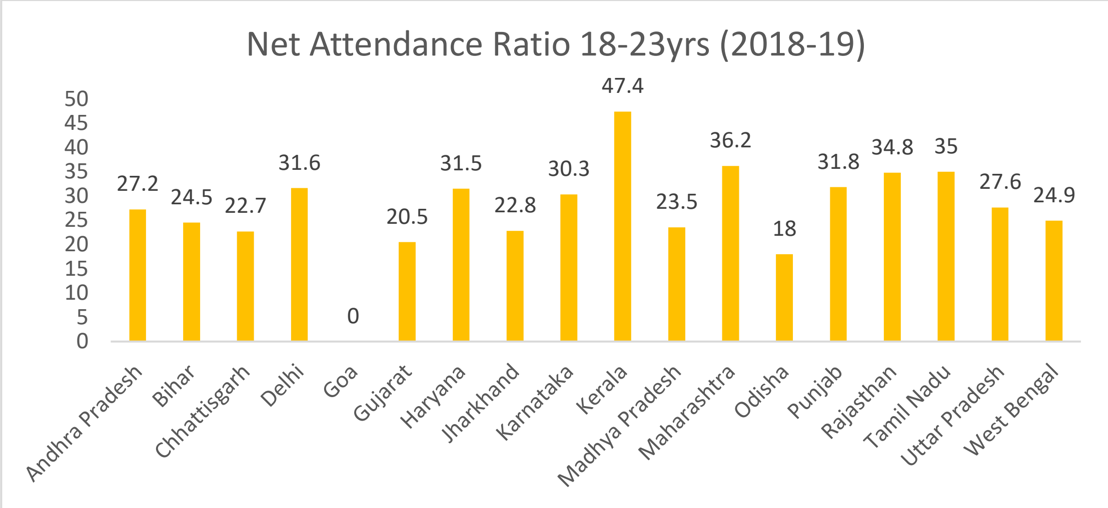

Fig. 5. 23-NAR of 18-23yrs (Group A)

While enrolment partly indicates participation, a more robust measure is by measuring attendance. While enrolment is indicative of intent to be present and being admitted to a coursework, attendance is more precise in showing the proportion of enrolled who actually attend classes. The difference between enrolment and attendance might appear to be small intuitively. However, as the data in Fig.5.18 shows, it is pretty significant with a cumulative average of 27.2 across Group A states. Kerala emerges as the top performer at 47.4, while barring Goa (because of the issue of missing data), the lowest ranked state is Odisha at 18. Lower attendance in higher education has multiple causes and can be spurred because of low students' motivation, poor quality of education, inadequate infrastructure etc. Thus, attendance ratio is a telling indicator of the actual participation and the existing status of Indian states as disclosed by the poor NAR is a cause of concern.

5.3.3.1.2 Analysis of Group A QPI Score

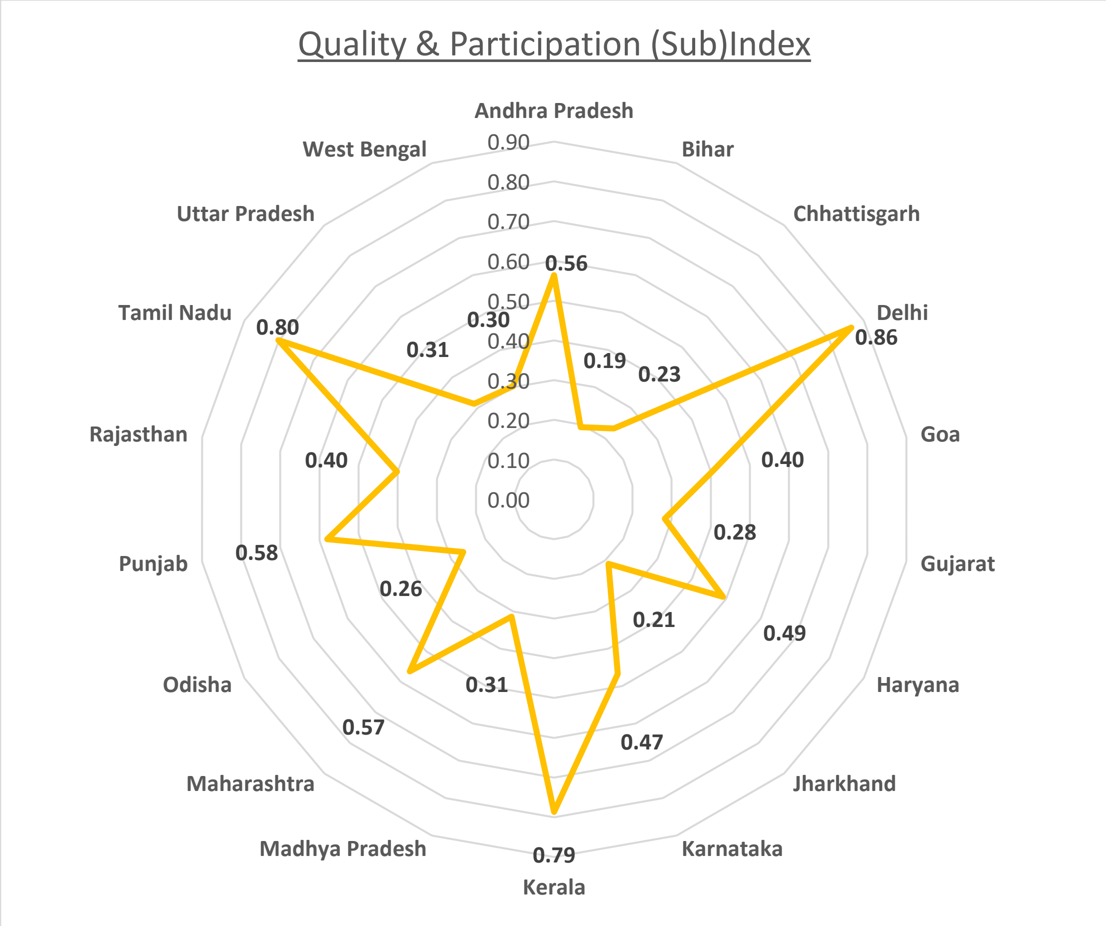

Fig. 5. 24-QPI (Sub) Index - Group A States

The Quality and Participation Sub-Index score indicates the performance of each state in terms of the youth's participation in higher education as well as the quality of institutes. It is apparent from Fig.5.19 that Delhi with a score of 0.86, Tamil Nadu with a score of 0.80 and Kerala with a score of 0.79 are the top performers as far as quality and participation in higher education is concerned. Bihar (0.19), Jharkhand (0.21) and Chhattisgarh (0.23) rank as the bottom three. With an average score of 0.44, Group A states still have a long way in ensuring a greater participation alongside improved quality of HEIs.

5.3.3.2 Group B States (Special Category States)

5.3.3.2.1Analysis of Indicators incorporated in the Group B QPI Score Calculation

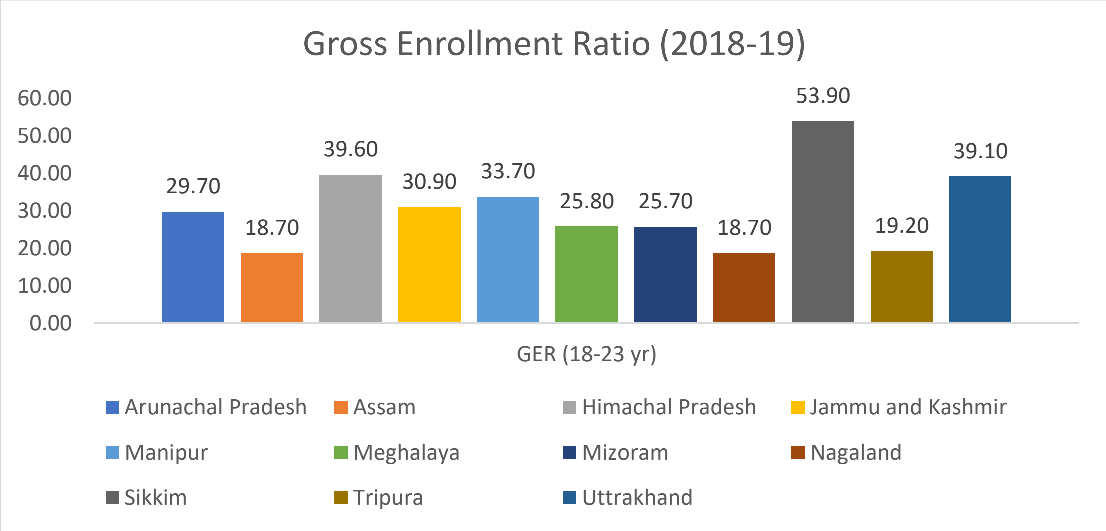

Fig. 5. 25-Gross Enrolment Ratio (Group B)

With an average GER of 30.45, Special Category States also lag behind in ensuring greater participation of youths in higher education. This deficiency is clearly visible from Fig.5.20, where only one state has crossed the halfway threshold – Jammu & Kashmir (53). Meanwhile, the average performance of states combined is at 30.45, which is not heartening either. The lowest ranked state is Nagaland and Assam at 18.70 each.

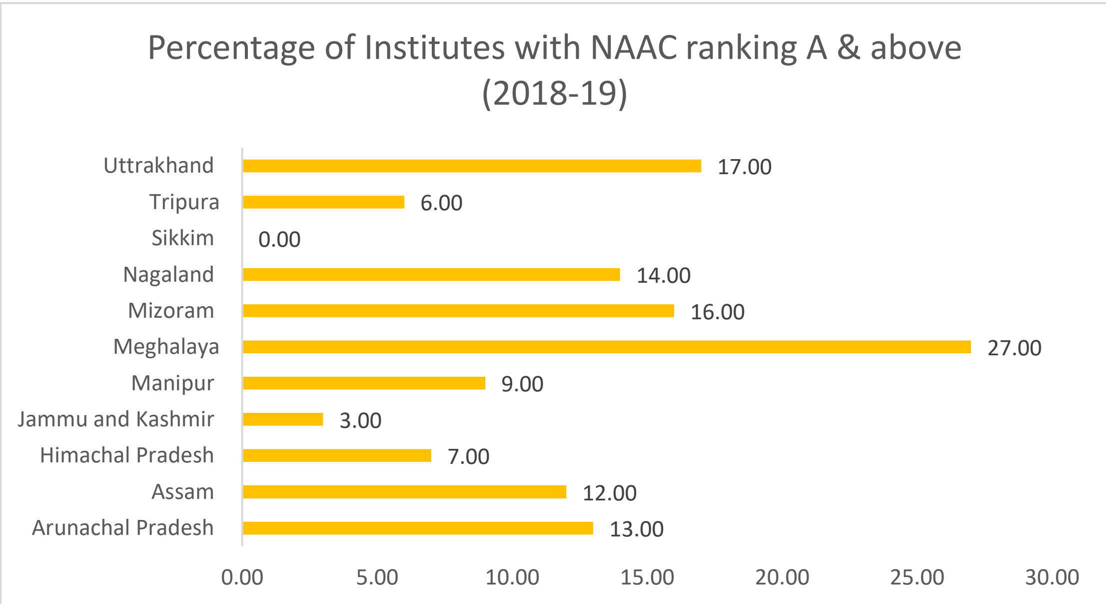

Fig. 5. 26-Percentage of Institutes with NAAC ranking A and above (Group B)

To assess the quality of HEIs of Group B states, the percentage of institutes ranked A and above in the NAAC ranking provides a glimpse on the elusive dimension of quality. As can be observed from Fig.5.21, Meghalaya with 27% of its institutes obtaining accreditation of A and above, ranks the highest in the Special Category States. Meanwhile, Sikkim ranks the least at 0%. Clearly quality assurance is a key challenge which continues to plague Indian HE.

5.3.3.2.2 Analysis of Group B QPI Scores

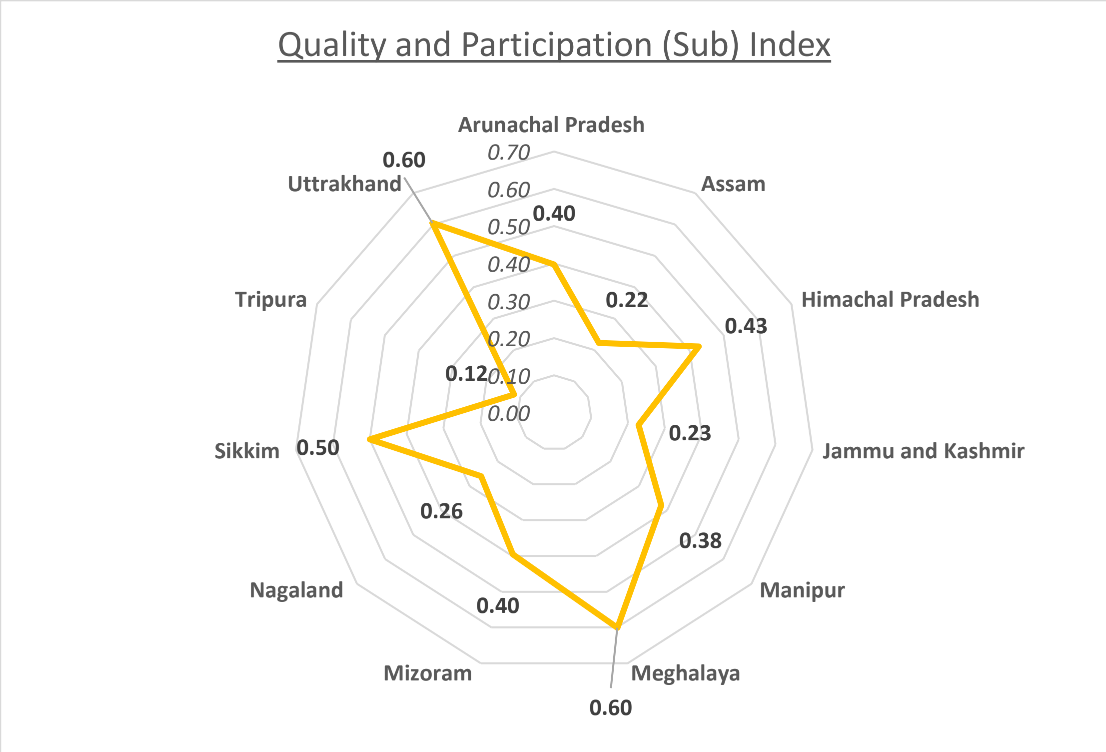

Fig. 5. 27-QPI (Sub) Index - Group B States

Altogether, the analysis of QPI scores of Group B reveals how both Uttarakhand and Meghalaya emerge as top scoring states with a score 0.60. Another interesting observation is despite Sikkim's apparent worse performance in the quality indicator, it has ranked second highest by the virtue of the high rates of enrolment which has considerably offset the poor NAAC performance. Tripura with a score of 0.12 is at the bottom of the ladder. Other mid-lower ranked states include Assam (0.22), Jammu & Kashmir (0.23) and Nagaland (0.26). Meanwhile the mid-to-top ranked states include Himachal Pradesh (0.43), Arunachal Pradesh and Mizoram (0.40), and Manipur (0.38). From Fig.5.22, it can be deducted how in quality and participation dimension, a vast disparity exists within states and yet the overall trend leaves considerable room for improvement.

5.4 Comparison of State's performance in HEFW Scores

The composite index calculated for both Group A and Group B is classified based on their scores and accordingly illustrated in Fig.5.23 and Fig.5.24.

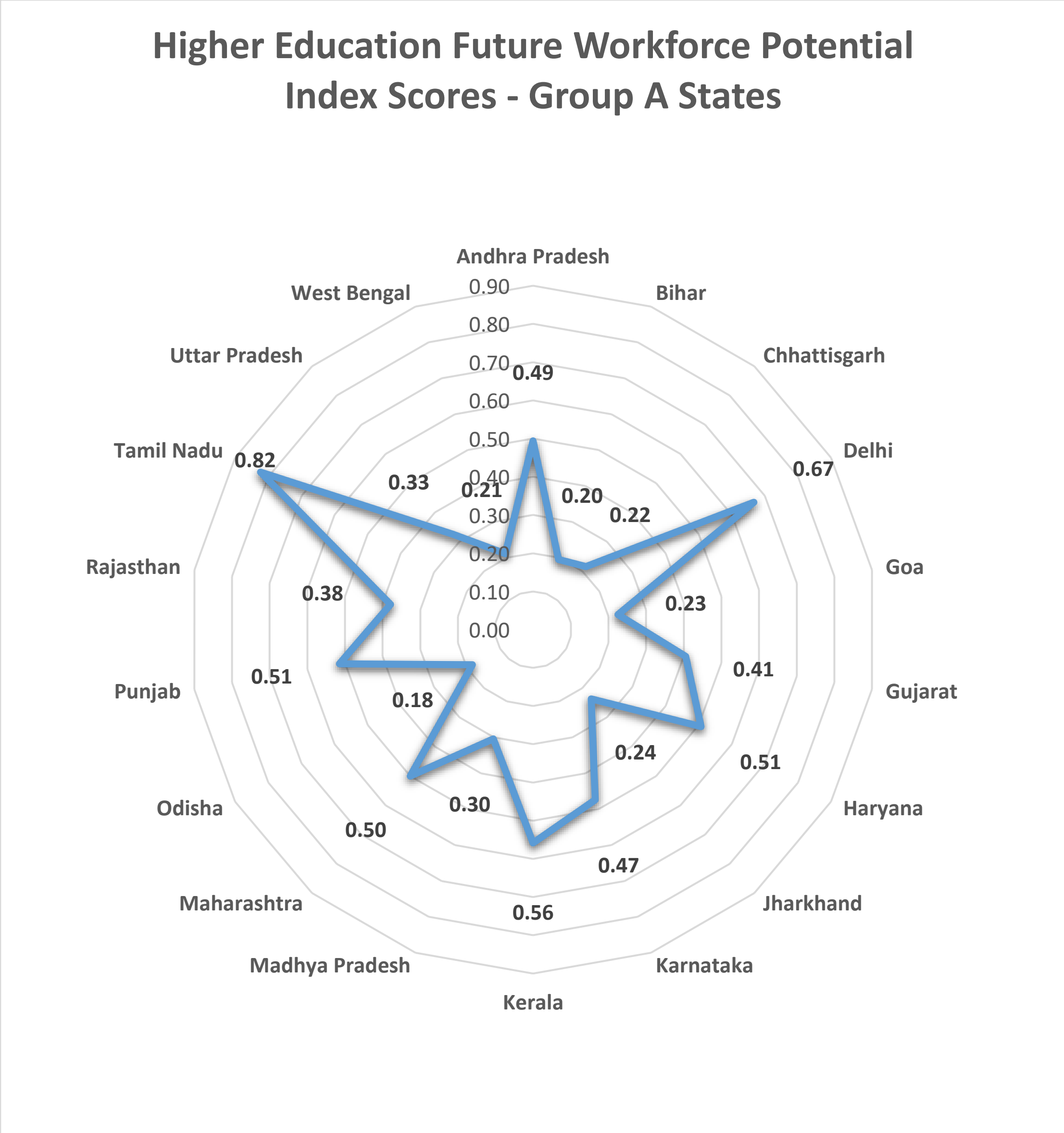

Fig. 5. 28-Higher Education Future Workforce Potential Index Scores - Group A Scores

For Group A states, as observed from Fig.5.23, Tamil Nadu with a score of 0.82 is the highest scoring state with a huge margin vis-à-vis other state. Delhi comes second at 0.67 followed by Kerala (0.56), Haryana (0.51) and Maharashtra (0.50). The lowest scoring states are the usual suspects – Odisha (0.18), Bihar (0.20), West Bengal (0.21) and Chhattisgarh (0.22). The scores obtained is largely consistent with the ground realities as well. For instance, Delhi being the national capital has natural advantage of housing some of the best institutes of India. The high concentration of universities, research infrastructure all favourably add up to build its capacity for delivering quality future workforce, who are well equipped with topical skill set.

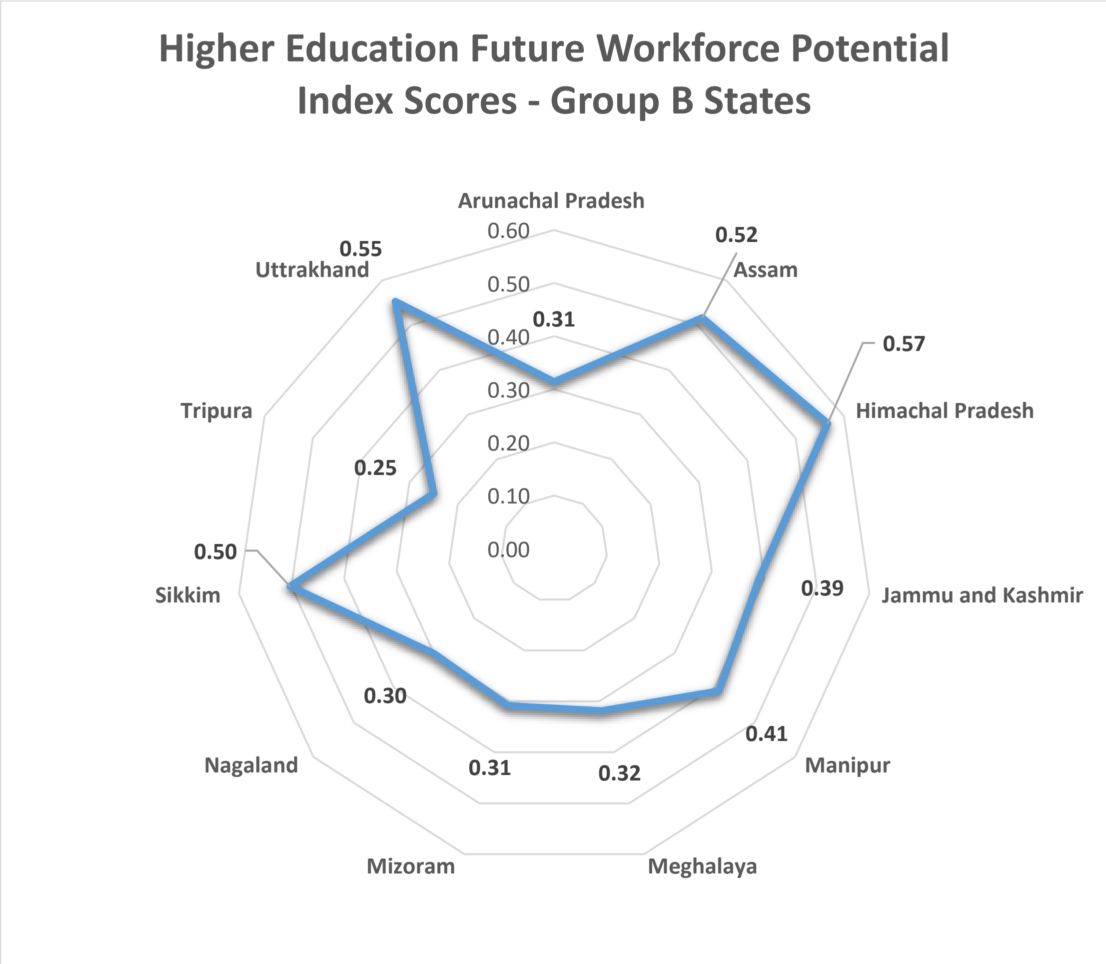

Fig. 5. 29-Higher Education Future Workforce Potential Index Scores - Group B Scores

In expected lines, the highest HEFW score of Group B state is lower than Group A states, thereby also validating the justification. Himachal Pradesh scores the highest at 0.57 and trailing close behind there is Uttarakhand at 0.55, followed by Assam and Sikkim with a score of 0.52 and 0.50 respectively. The results are also consistent with the observed level of HE penetration in the states. In the last two-decade, H.P has brought about considerable improvement in the education sector with equal emphasis on research and innovation. The high score is indicative of its relatively superior performance. Meanwhile, among all north-eastern states, the performance of Assam stands out, which can partly be attributed to its large state capacity which translates into improved performance of HE in meeting the requirements of future workforce.

5.5 Overall HEFW Performance in India & its Regional Variation– Key Findings

The aggregation of the cumulative state-wise scores provides a macroscopic view of India's Higher Education's potential in realizing future workforce demand. On the whole, India scores 0.40 in the HEFW index. This shows the untapped potential of the country, and is indicative of the gap in leveraging India's demographic dividend. To obtain a granular view, the scores are further sub-classified as high scoring for ease of comprehension. The classification of score is on the following basis –

1. High – Scores between 0.66 to 1
2. Medium – Scores between 0.33 to 0.66
3. Low – Scores between 0 and 0.33

Table 5. 2-Classification of States based on Scores of Sub-Indices and HEFW Index (Group A)

Normal Category States	SEI		RII		QPI		HEFW	
Andhra Pradesh	0.56	Medium	0.36	Medium	0.56	Medium	**0.49**	Medium
Bihar	0.20	Low	0.19	Low	0.19	Low	**0.20**	Low
Chhattisgarh	0.16	Low	0.25	Low	0.23	Low	**0.22**	Low
Delhi	0.77	High	0.37	Medium	0.86	High	**0.67**	High
Goa	0.19	Low	0.09	Low	0.40	Medium	**0.23**	Low
Gujarat	0.41	Medium	0.53	Medium	0.28	Low	**0.41**	Medium
Haryana	0.60	Medium	0.44	Medium	0.49	Medium	**0.51**	Medium
Jharkhand	0.31	Low	0.19	Low	0.21	Low	**0.24**	Low
Karnataka	0.51	Medium	0.45	Medium	0.47	Medium	**0.47**	Medium
Kerala	0.61	Medium	0.28	Low	0.79	High	**0.56**	Medium
Madhya Pradesh	0.22	Low	0.38	Medium	0.31	Low	**0.30**	Low
Maharashtra	0.48	Medium	0.46	Medium	0.57	Medium	**0.50**	Medium
Odisha	0.19	Low	0.10	Low	0.26	Low	**0.18**	Low
Punjab	0.52	Medium	0.44	Medium	0.58	Medium	**0.51**	Medium
Rajasthan	0.38	Medium	0.35	Medium	0.40	Medium	**0.38**	Medium
Tamil Nadu	0.75	High	0.92	High	0.80	High	**0.82**	High
Uttar Pradesh	0.19	Low	0.47	Medium	0.31	Low	**0.33**	Low
West Bengal	0.14	Low	0.19	Low	0.30	Low	**0.21**	Low

For Normal states, as can be observed from Table 5.2, states like Bihar, Chhattisgarh, West Bengal, Jharkhand, and Odisha have consistently scored the lowest in the sub-indices as well as the HEFW index. The low score is essentially a consequence of the low emphasis on science and technology, building state research capacity, and improving the quality of HEIs. Although the other states have conventionally ranked low in development parameters, the inclusion of West Bengal at first glance might appear surprising given that it has historically been touted as a state where the population values education. The low score is valid because the three dimensions and the HEFW are not so much about appreciating higher education and the proportion of the population with a higher education degree. Instead, it indicates how well the HEIs prioritize future workforce requirements and accordingly provide streamlined support by revamping curriculum, conducting training sessions, investing in infrastructure, financing in relevant priority areas, etc. West Bengal is not an outlier because its performance in the sub-dimensions has been lacking. Therefore, its low HEFW score is aligned with exactly what it is supposed to capture - not the state's involvement in higher education, but the deficiency of a state in providing for the workforce of tomorrow.

A disaggregation of HEFW scores further disclose how only 11.11% of the states have ranked in the high score category. An overwhelming 88.88% of the states are equally distributed with either a position in the low rank category (44.44%) or in the middle rank category (44.44%). As such, there is a lot of room for improvement. Especially given their relative advantage in state capacity, these states should invest heavily in the future workforce as it has direct bearing on their economic growth as well.

Table 5. 3-Classification of States based on Scores of Sub-Indices and HEFW Index (Group B)

Special Category States	**SEI**		**RII**		**QPI**		**HEWF**	
Arunachal Pradesh	0.30	Low	0.24	Low	0.40	Medium	**0.31**	Low
Assam	0.49	Medium	0.84	High	0.22	Low	**0.52**	Medium
Himachal Pradesh	0.60	Medium	0.67	High	0.43	Medium	**0.57**	Medium
Jammu and Kashmir	0.34	Medium	0.60	Medium	0.23	Low	**0.39**	Medium
Manipur	0.51	Medium	0.34	Medium	0.38	Medium	**0.41**	Medium
Meghalaya	0.21	Low	0.14	Low	0.60	Medium	**0.32**	Low
Mizoram	0.43	Medium	0.10	Low	0.40	Medium	**0.31**	Low
Nagaland	0.50	Medium	0.14	Low	0.26	Low	**0.30**	Low
Sikkim	0.72	High	0.28	Low	0.50	Medium	**0.50**	Medium
Tripura	0.63	Medium	0.00	Low	0.12	Low	**0.25**	Low
Uttarakhand	0.44	Medium	0.61	Medium	0.60	Medium	**0.55**	Medium

When analysing sub-indices of Group B states, it becomes evident that the aggregate performance is best in the SEI with an average score of 0.47 followed by QPI with an average of 0.38. The performance at RII 0.36 is the poorest of the three. The low score of RII can be intuitively anticipated because investing in infrastructure mostly comes as an afterthought, especially for regions with low state capacity. This is largely because building research infrastructure is often expensive and entails a huge opportunity cost. Consequently, the number of low scoring states in RII is high, as can be seen from Table 5.3.

Nevertheless, with an average HEFW score of 0.40, the performance is noteworthy because it is the same as the average of Group A. Despite low state capacity, the same average for both the group indicates that states in Group B are faring better in reaping and realising the potential of their existing manpower vis-à-vis Group A states. While it is somewhat relieving that the score of 55% of Group B state have scored in the medium range, the fact that the other 45% of the states have scored in the low range is concerning. Worse still, none of the Group B states have scored in the high score range. Thus, policy needs to be suitably aligned to remedy this situation.

Finally, the pictorial representation of the map in Fig.5.25 makes it visually clear that India’s performance with regards to providing future workforce still has a lot of catching up to do. The performance of eastern states is the worst, as most of the low ranked states are concentrated in the central and eastern part of the country. Comparatively, southern states have performed the best, followed by the northern region.

With an overwhelming proportion (48.24%) of the state's coloured in yellow, i.e., obtaining a medium ranked score, it is an indication that most Indian states need to prioritize workforce development that is suited to the demands of the knowledge economy. Worse still, 44.82% of all Indian states have fared very poorly with a HEFW score in the low range. Furthermore, it is deeply problematic that a country boasting of its natural advantage in demographic dividend has only two states which have achieved a high score. Thus, the overall distressing performance of the Indian states, as revealed by the HEFW Index is consistent with the national employability and innovation reports. Both suggest a significant undersupply of suitably trained workforce for future industries, despite the recent decade’s upshoot in higher education enrolment rates.

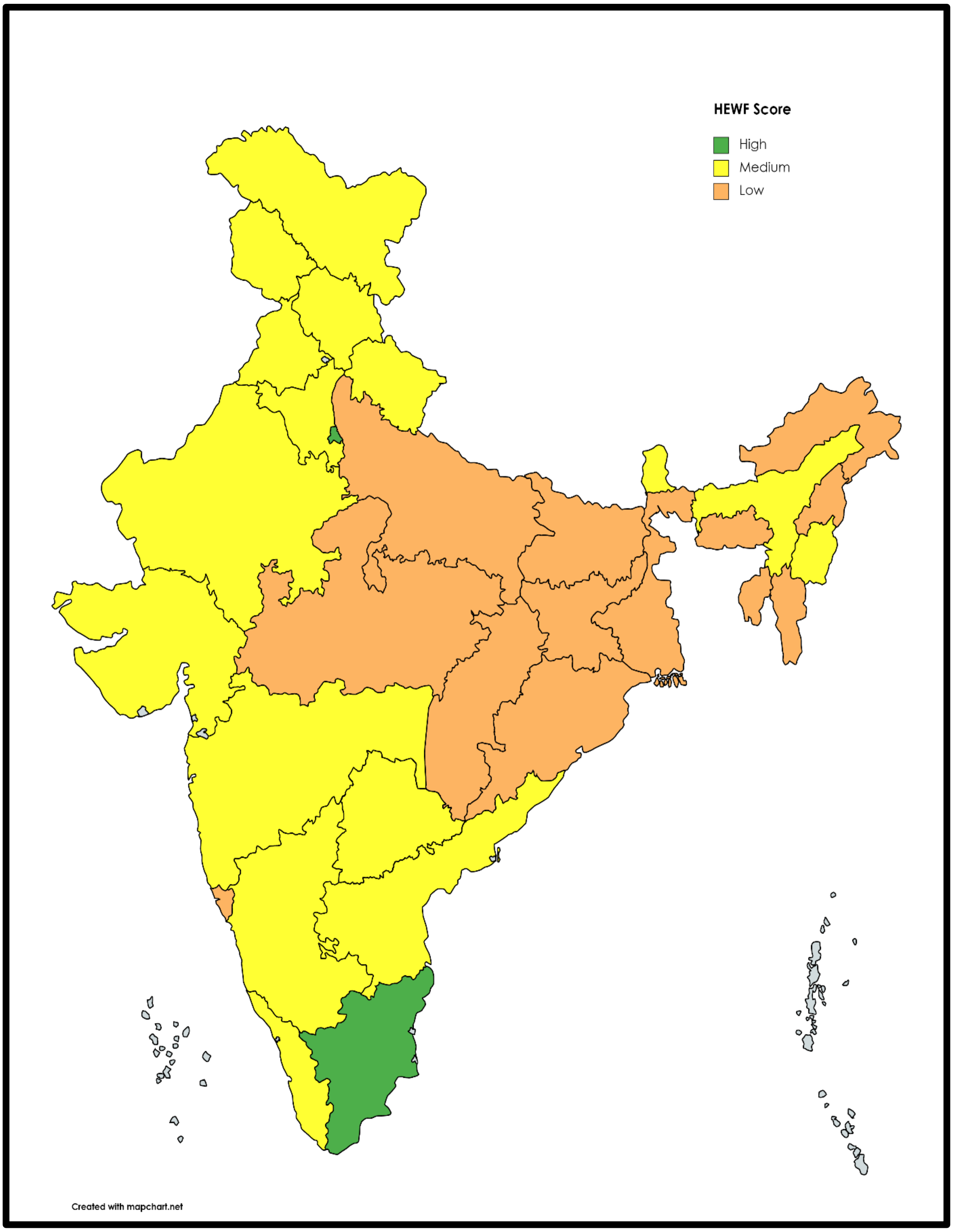

Fig. 5. 30-Performance of States on HEFW Index

CHAPTER 6

HEFW, GROWTH AND COMPETITIVENESS IN INDIAN STATES

6.1 Background

The preceding chapters have outlined the crucial driver of the future workforce tendencies. Accordingly, based on these trends, the HEFW index was formulated to encapsulate the critical indicators aligned to the future workforce needs. However, the robustness of the indicator is yet to be determined. It also remains to be determined how accurately the index sits with the existing literature – whether it consolidates the existing relationship or defies it.

For demonstrating the soundness of the composite index and uncover its relation with economic growth, the index is examined alongside two parameters– competitiveness and NSDP. While the rationale for taking NSDP to a considerable degree is self-explanatory, the grounds for choosing competitiveness is its ability to reveal whether an economy is factor-driven, efficiency-driven, or innovation-driven. Competitiveness scores are measured in a way that high innovation economies are ranked higher vis-a-vis other regions. Since the paper's focuses on optimizing higher education in a way that augments and propels an innovation-driven economy, analyzing the index with competitiveness ranking is reasonably justified.

6.2 HEFW Index and Competitiveness of Indian States

The World Economic Forum defines competitiveness as "the set of institutions, policies and factors that determine the level of productivity of a country" (Schwab & Sala-i-Martín, 2017). Other definitions postulated by a variety of organizations are broadly consistent with this definition. The commonality across all definitions is the emphasis put on the 'productivity' of an economy which effectively means the value derived per unit of input. Thus, in essence, a country or region's improved competitiveness enables it to utilize its resource base efficiently. The notion of 'competition' from which the etymology of the word competitiveness can be traced, indicates the underlying competition among the countries and states to offer the most productive environment for business and industries.

The role of HEIs in driving competitiveness is vital – as the WEF competitiveness report reiterates that in innovation-driven economies such as the OECD countries, for every $1 million invested in public R&D, five new jobs are created. The number of jobs becomes twice as many if the investment is routed through higher educational institutes (Schwab & Zahidi, 2020). Moreover, the importance of higher education becomes apparent from the fact that it constitutes one of the twelve pillars included in the 'competitiveness' rankings. The report contends that high education nurtures well-educated workforce capable to meet the "evolving needs of the production system".

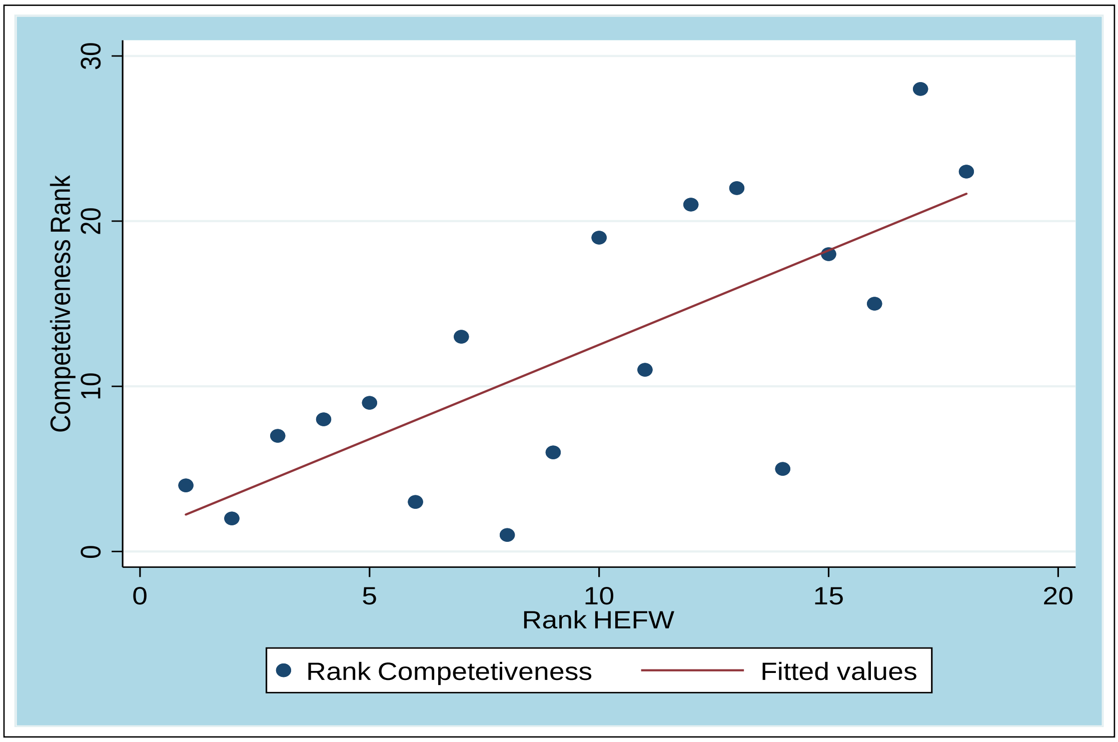

Fig. 6. 1-Scatter plot of State's HEFW Index ranking & Competitiveness rankings (Group A States)

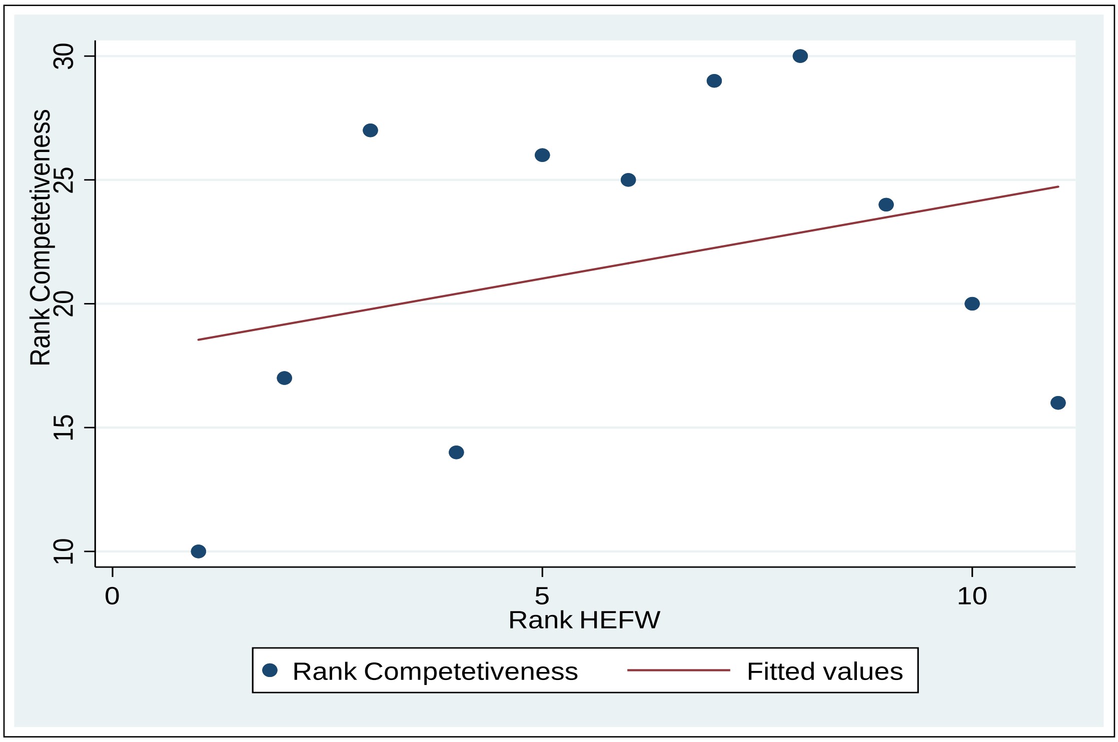

Fig. 6. 2-Scatter plot of State's HEFW Index ranking & Competitiveness rankings (Group B States)

Although the literature has sufficiently established the strong linkage between the competitiveness of a region and Higher Education, it needs to be resolved whether the same holds true for HE's future workforce potential. Intuitively, it makes sense for a strong positive relation to exist between the index and competitiveness as enhanced suitability of the workforce to navigate future job roles will have direct bearing on the competitiveness of an economy.

The correlation of HEFW Index and State Competitiveness Rank of 2017 [6], as released by the Institute of competitiveness (Kapoor, 2018), can be observed from the scatterplot of their rankings as shown in Fig.6.1 and Fig.6.2. As revealed by the direction and concentration of points in the scatterplot, with a correlation of 0.73 for Group A States and 0.30 for Group B states, overall, the HEFW Index and State competitiveness are positively correlated. Although the source and the cause of the correlation cannot be deciphered, the strength of the relation confirms that either higher education through its impact on workforce improves competitiveness or alternately, improved

[6] Only the rank was provided without any other imputed score. As such, the correlation had to be carried by first ranking HEFW scores of states and then correlating it with the state's competitiveness ranking. To ensure consistency, even for the correlating of NSDP and HEFW scores (in the next section), the same was done.

competitiveness of a region has direct bearing on higher education's ability to augment future workforce development. In most likelihood, it's an interactive mechanism, but scrutinizing that is beyond the scope of this paper.

6.3 HEFW Index and Economic Growth in Indian States

Apart from the numerous growth theories highlighted in the introduction, there are a plethora of empirical studies worldwide which confirm these findings and establish the relationships that better human capital leads to labour force augmentation, which in turn leads to economic growth mediated by technology:

- Jimmy Alani (Alani Jimmy, 2018) analyses conducted in Kenya found human capital to influence economic growth in the long run positively. Human capital also had a positive influence on labor in the long run. The paper further contends that both human capital formation and technological progress should be prioritised instead of simply increasing capital or labour productivity.

- For South Africa, too, Johannes (Fedderke, 2005) shows a positive impact of human capital on total factor productivity, especially in the form of growth by innovation, in the Schumpeterian sense. In West Africa, especially in Ghana, the impact of human capital development was found both in the short run as well as in the long run (Ayertey Odonkor et al., 2018).

- Van et al. (Le Van et al., 2010) confirmed in their study that the quality of production of new technology, the supply of skilled workers, and the share of investment in human capital is the source of the phenomenal economic growth trajectory of Asian countries like China, Korea, and Taiwan. Technology and human capital reinforced and improved the Total Factor Productivity, which ultimately led to higher economic growth.

- Even for Europe, using large-scale data to analyse the 19th and 20th century situation, Claude Diebolt & Ralph Hippe (Diebolt & Hippe, 2019) find that past regional differences in human capital are crucial in explaining the existing regional disparity in both innovations as well as economic development.

- Comparing the economic growth across advanced industrialized economies, Ketteni et al. (Ketteni et al., 2011) revealed how countries with high levels of human capital had high output elasticities of ICT.

- Connecting education and maximum optimization of technology, Edgardo (Bucciarelli et al., 2010) further show that an inadequately educated workforce cannot effectively take advantage of high technologies at all.

A plethora of empirical evidence alongside growth theories supports the claim that there is a strong linkage between technology-mediated growth and education. Given the established results, cross-checking the HEFW with the economic growth of different regions augment these theories. Meanwhile, it also validates the index since it measures future workforce potential of HEIs specifically suited for the workforce requirement of industry 4.0.

To undertake the correlation between economic growth and HEFW, we consider each state's NSDP (constant) values in the period 2018-19. The rationale for considering NSDP in lieu of GSDP is because depreciation (which is deducted from GSDP for obtaining NSDP) does not increase an economy's capacity. As a result, GSDP can simply grow because of spending more money to maintain capital stock. Such a growth does not imply that someone has been made better off (Spant, 2003).

Correlation between the HEFW and NSDP for normal states is 0.49, while for special category states it is 0.64 – the results indicating a strong positive correlation confirm the validity of the index as it can be instinctively comprehended that an improved HEFW indicated improved workforce ability, which in turn contributes to economic growth. Furthermore, the results are also on par with previous empirical findings enumerated above. The scatter plot of the correlation alongside the trendline is shown in Fig.6.3, and Fig6.4 for Group A states and Group B states, respectively.

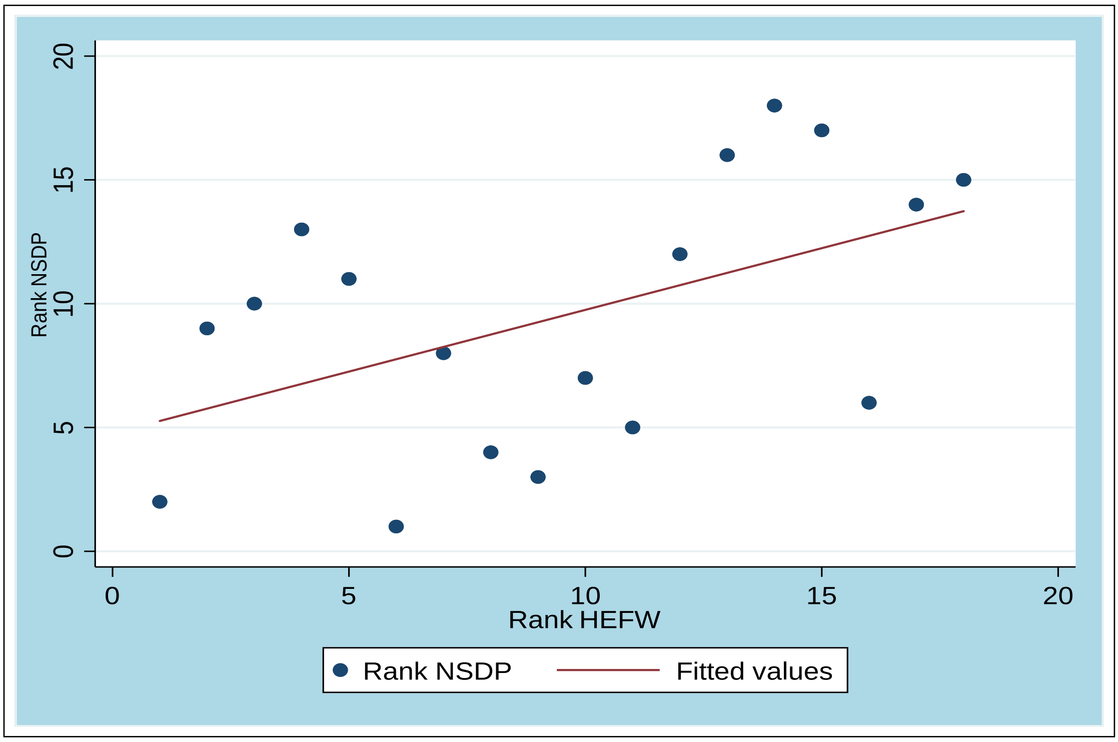

Fig. 6. 3-Scatter plot of State's HEFW Index ranking & NSDP rankings (Group A States)

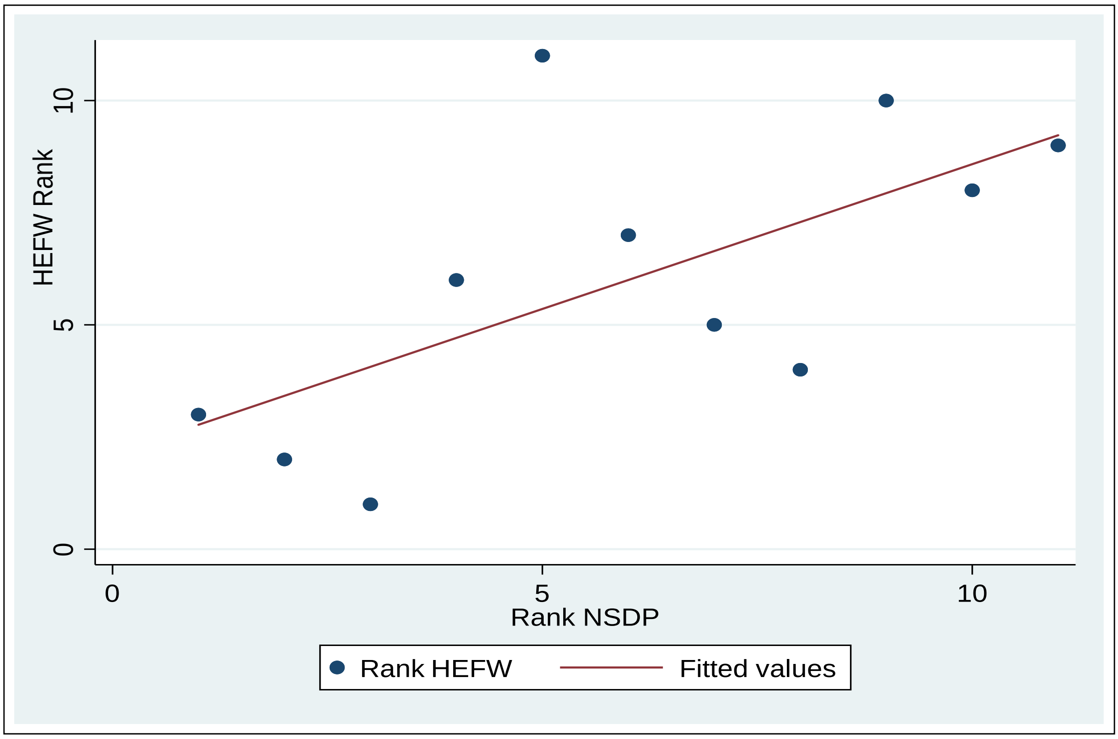

Fig. 6. 4-Scatter plot of State's HEFW Index ranking & NSDP rankings (Group B States)

6.4 Implications

The strong positive correlation for both NSDP and HEWF, and, Competitiveness and HEFW, shows that there is a strong connection between the variables. Although the result is consonant with previous theories and empirical evidence linking higher education, growth and competitiveness, it is now established also for higher education's responsiveness in meeting future workforce demands, as indicated by the HEFW index. Since this linkage was already established in the literature to a considerable extent, the correlation ascertained the soundness of the index too.

Fig. 6. 5-Linkage between HE, WfD, Competitiveness and Economic Growth

The link between higher education and competitiveness has remained somewhat of a black box mostly. The HEFW index with each of its sub-indices directly improving the competitiveness, be it skill and employability or participation or level of research and innovation in the region, demystifies this black box as all sub-indices directly aid in providing the workforce with an additional edge via the tactic knowledge which students acquire.

Again, the bi-directional nature of this relation entails that improved competitiveness could also lead to a greater demand for adequately trained skilled professionals, thereby driving up the demand for specific qualifications in higher education that are in accordance with the industry requirements. This, in turn, would route investments in greater research, quality improvement, and skilling undertaken in the higher education sector.

Likewise, while workforce development attuned to future industry requirements enhances economic growth by improving productivity and fostering innovation in the economy, a higher economic growth ensures a greater resource base for further channeling investments in capacity building via higher education and other channels.

Ultimately, although causality remains to be established and can be the scope of future research, the interactive mechanism between higher education, workforce development, improved competitiveness, and economic growth is confirmed.

CHAPTER 7

CONCLUSION

7.1 Findings

This research aimed to answer how well aligned India's HE sector is in meeting future workforce requirements. Based on the quantitative analysis of the Composite Index – Higher Education Future Workforce (HEFW) Index, it can be concluded that on an average Indian HEIs has fallen short for delivering future workforce requirements. By analysing and condensing the various indicators of higher education of the last four years, the HEFW index has provided a single point data for enabling ease of comparison of a state's higher education system. As such, the index succeeds is quantitatively measuring the otherwise intangible benefits accrued from partaking a HE degree.

With regards to inter-state variation, the HEFW scores reveal that with a notable exception of two states, namely Delhi and Tamil Nadu, the HEIs of all other states are underprepared in delivering for future workforce requirements and aiding to WfD. The results clearly indicate the inadequacy of higher education and reveal the jarring inequality among states. Further decomposition of sates performance for both normal category state and special category state is summarized in the following tables –

Table 7. 1-States which performed the best and worst – Normal Category

		Best Performing State	**Score of Best Performing State**	**Worst Performing State**	**Score of Worst Performing State**
Sub-Index	**SEI**	Delhi	0.77	West Bengal	0.14
	RII	Tamil Nadu	0.92	Odisha	0.10
	QPI	Delhi	0.86	Bihar	0.19
Composite Index	**HEFW**	Tamil Nadu	0.82	Odisha	0.18

Table 7. 2-States which performed the best and worst - Special Category

		Best Performing State	**Score of Best Performing State**	**Worst Performing State**	**Score of Worst Performing State**
Sub-Index	**SEI**	Sikkim	0.72	Meghalaya	0.21

	RII	Assam	0.84	Tripura	0.00
	QPI	Uttarakhand	0.60	Tripura	0.12
Composite Index	**HEFW**	Himachal Pradesh	0.57	Tripura	0.25

Concerning the relation between ‘competitiveness and HEFW’ as well as ‘growth and HEFW’, a positive relation was observed for both. Since a correlation was done, the direction and causality cannot be established, but the positive relation is aligned with previous empirical studies and literature. It is further an indication of the validity of the index as well.

7.2 Summary

Chapter-wise summary (with the exception of the introduction) is detailed as follows:

- The chapter titled 'Future workforce- drivers and trends' provided a comprehensive account of the most critical factors driving future growth. These drivers of change include IR 4.0, digital platforms, clean energy, the Covid19 pandemic, and other socio-political changes. Not only do these drivers spur economic growth, but they also change the way society functions. Consequently, these changes have direct bearings on how the work regime is organized and conducted. Premised on these factors, the chapter further details the emerging workforce trends like the increased uptake of gig work, rising automation across sectors (primary, secondary and tertiary), the upsurge in remote work, increased career opportunities in STEM-related fields, and the phenomenon of 'skill-biased technology change.' These trends reveal the rising dichotomy which can now be witnessed in the labour market.

  On the one hand, the high-paying innovation-centric careers are becoming lucrative with increased wages. On the other hand, the growing demand for workers in the gig economy shows the dire state of low skilled labour force. Individuals engaged in such low-skilled gig-work (such as delivery personnel for platform companies) are pushed further into the margins as such jobs provide no social security or tenure security. Instead, they often fall under a 'self-employed' category and are treated as independent contractors. Overall, this chapter reaffirms that, with a fragmented labour force, 'Skill Biased Technology Change' is already underway in India.

Furthermore, as the chapter contended, Covid 19's impact on ushering a new work order mediated by technologies has been immense. The social distancing norms have accelerated the uptake of emerging technologies alongside future work trends such as an increase in the scale of Gig economy, STEM jobs, surge in remote work, etc.

- The chapter on 'Higher Education and Future WfD' builds on the findings of the previous chapter. As was established earlier, given the ensuing bifurcation of the labor market, it is best to channel resources to make the workforce capable enough to benefit from high-skilled job roles. However, for this to materialize, it would require sufficient investment in building human capacity, which can be ensured through higher education. The chapter illustrates the unique advantage higher education has in delivering for future workforce requirements. Nevertheless, many systemic issues are plaguing the higher education sector of the country. These deficiencies in HEIs thwart graduate's capabilities, crippling their employability prospectus. These bottlenecks are essentially a result of HEIs failure to keep updated with the current times. For instance, although we are currently in IR 4.0 regime, the education system is stuck and caters to the workforce for the initial days of the industrial revolution. From the analysis of literature and theoretical paradigms, the chapter outlines the conceptual framework of the study. Briefly, the conceptual framework depicts how higher education fulfils two essential requirements of workforce development - by supplying skilled personnel who improve the productivity of industries and dispensing graduates endowed with R&D capabilities for ushering innovation in the economy. These are the two ways higher education aids in workforce development, leading to economic growth and boosts competitiveness. However, the two major bottlenecks that include appalling quality and low participation levels hinder higher education's WfD potential.

- The chapter titled 'HEFW Index - an exposition of the adopted procedures' is the methodology chapter. Since the study's significant findings are derived from the HEFW index, this chapter laid bare the intricacies involved and the basis of decision-making while constructing the index. It outlines how employing an index enables ease of assessment, among other benefits. A five step-by-step methodology in the construction are as follows: firstly, crafting the conceptual framework; secondly, the criteria for variable selection; thirdly, the technique of assigning weights; fourthly deciding on the aggregating criteria; and fifthly, the robustness check. From the previous chapter, the three determinants of higher education's future workforce potential were arrived at - skills for employability provided by HEIs, research and innovation enabled by HEIs, and quality and participation at HEIs. To ensure cross-comparability of each of the three determinants, the three dimensions have been designated as a sub-index, incorporating their respective indicators. Finally, the three sub-indices were aggregated to arrive at the composite HEFW index. The limitation of the index has been elaborated upon as well.

- The chapter designated 'higher education future workforce potential of Indian states' provides glaring insights on each state's performance in terms of the indicators, including the sub-indices and, finally, the HEFW index. The chapter argues that although the rationale is to enable inter-state comparison, given the acute heterogeneity within Indian states, it is unlikely that comparing them together would lead to meaningful results as some states have better state capacity relative to others. So, the states have been classified as the Group A States or the Normal Category States, and the Group B States or Special category states. The Group B states are those which have some disadvantage owing to state capacity. After obtaining the results, each state has been ranked based on the index score obtained. The score range is between 0 and 1, with a value closer to 1 indicating better performance and closer to 0 implying worse performance. The states have been further sub-classified into high-ranking states (those with an index score between 0.66 to 1), medium ranked states (scores between 0.33 to 0.66), and the laggard states (scores between 0 and 0.33). These results have already been elaborated on above in the first section of this chapter.
- HE is the performer for a significant chunk of basic research and birthplace of future scientists and engineers – their centrality and explicit role in aiding

competitiveness can also be taken up in future research. The primacy obtained by higher education can be owed large parts to the tactic knowledge it endows students with. All the hue and cry about technology being at the helm of shaping the future societies lead us to forget that technical know-how and scientific acumen are embodied in humans rather than machines. Consequently, the focus needs to be redirected to building human capacity for making them resilient to the uncertainty of changing work order. It is individuals who are the frontrunner even in Industry 4.0 paradigm rather than devices or equations. The HEFW gives a quantitative value for measuring the preparedness level of the workforce resulting from higher education. This relationship is firmly established in the chapter titled 'HEFW, Growth and Competitiveness' which ascertains a strong positive relation for both 'HEFW and NSDP' and 'HEFW and Competitiveness'.

7.3 Reflections

As can be realized from the chapter summaries, each chapter moves forward and builds on the preceding one, and can be understood as an extension of the former. When 'clubbed together, they provide a holistic viewpoint of 'HE and Future WfD in India'.

The findings of this dissertation have several implications. A country's human capital stock may not be a growth source when educational quality is low. Low-quality education exacerbates the challenge of ensuring youth are well prepared for labor force participation, mainly if the majority have acquired only primary education and have to resort to low-page semi-skilled work. To become a highly-skilled knowledge economy necessitates a pool of sufficiently skilled workforce instead of the existing abundant cheap worker, archetypal of the Indian labour force. It is vital to acknowledge that the knowledge economy relies on intensive development of human capital and to meet this requirement, sufficient attention needs to be given to developing a workforce whose capabilities are suited for upcoming human resource requirements. Thus, the focus on narrow vocational and technical skills needs to be abandoned, and instead, human capital formation needs to be prioritized.

There are a few limitations worth highlighting here. Firstly, data shortage and the data incorporated have varying timelines – for instance, one of the indicators is from 2018 and the other of 2020. Although this has an impact on the index's temporality, but it retains the robustness. Secondly, all the indicators included are not independent of each other. To better capture the interaction effect among the indicators, alternate statistical techniques such as factor analysis, and PCA could be considered, as they take into account multi-variability of indicators. However, as discussed in the methodology chapter, the given methodology was most apt despite this shortcoming. Thirdly, for a few exceptional indicators, the missing data were imputed as zero, which could pull the overall average value. However, because more than one indicator encompasses a dimension, the other indicators help level the score according to the States' performance in different indicators. Finally, mostly input variables was included in the index and suboptimal levels of output-based indicators were incorporated. This was done because to gauge future potential, it is inputs which stimulates outcomes and output of the future (such as an innovative activity).

Thus, the index has successfully scrutinized Higher education's potential in future WfD. It has enabled in ranking states based on the scores obtained. While commenting on the regional stratification of HEFW potential, the index can also guide government policies in directing attention to the challenging areas where a state is underperforming. Future research can add more dimensions and indicators (including more indicators revealing output performance) to improve the robustness of the findings and elaborate on the unique causes of high-performing states and laggard states. Another potential future research avenue would be conducting a regression analysis to decipher causality and direction of the strong association between 'HEFW and Competitiveness' and 'HEFW and NSDP'.

7.4 Policy Recommendations

The proposed index is a good starting point to initiate discussion about this topical and yet ignored aspect of HE as a WfD strategy. As the saying goes, "The best way to predict the future is to invent it." Slightly modifying it for future workforce development, the best way forward is to be sufficiently prepared for it. Unfortunately, the existing policy in skilling prioritizes and fixates on TVET, which entails an enormous opportunity cost for the HE sector. This fixation with vocational courses could prove expensive, especially since India aspires to transition to an innovation-driven economy. The comparative advantage should be tactfully built on the workforce engaged in high-wage high-skilled occupations. This is all the more important with Skill Biased Technology change underway. If vocational education is favoured over general tertiary education, the repercussion could entail workforce concentration in low and semi-skilled work.

Given the existing deplorable state of HEIs in meeting future workforce requirements, as ascertained by the HEFW index, raising awareness about this shortfall is vital in channelling greater investments to remedy the situation. The focus should be on building a national workforce catering to upcoming workforce requirements by developing regional higher education systems. This should be done to ensure regional equanimity instead of focusing on better-performing states alone. Multi university joint collaboration on research, skill-building, etc. should be fostered by linking better performing and lagging HEIs in India.

Regional equanimity is WfD is equally vital, as no country can realise the optimal potential or be regarded as a country with a sufficiently well-endowed workforce for Industry 4.0 if glaring disparities exist between the states. Lagging regions complain of neglect as they are severely underfunded. These states need special care to address their specific problems, especially in the sub-indices where they have respectively fared worse. To ameliorate this situation, the ranking can also be indirectly used as a form of benchmarking practice to enable policymakers in the higher education system to draft administrative and deveolopment guidelines and suggest appropriate reforms.

With the coronavirus outbreak leading to a surge in digital transformation, reforms are an exigency now. The National Education Policy of 2020 has accurately identified the deficiencies and has initiated some meaningful reforms. For instance, the move towards large multidisciplinary universities and colleges recognizes the need for 'T-skilled' people (elaborated in Chapter 3). Even the need for research-intensive universities has been duly recognised with the plan to establish a dedicated National Research Foundation(NRF). Regional disparity in HEIs has also received attention with the policy proposal to set up at least one large multidisciplinary HEI in every district and underserved region. Ultimately, future WfD is not an end in itself but an input toward broader goals—of boosting employability and productivity, relieving skills constraints on business growth and development, and advancing overall economic growth and social wellbeing. Policymakers should be wary that the window of opportunity available because of its demographic dividend is limited and the need for intervention is immediate. It is about time that majority of India's youth are trained and upskilled through higher education. This can only be achieved when India's HE sector is revamped and broadened without watering down the quality.

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