

28th August, 2025

Terms of Reference

1. Introduction

This document serves as the terms of reference (ToR) for the research support provided to Irfan Ahmad Sofi (Islamic University of Science and Technology, Awantipora), Mukhtar Ahmad Sofi (Vellore Institute of Technology, Vellore) and VVS Rajendra Prasad (Vishnu Institute of Pharmaceutical Education and Research, Hyderabad) by the New Political Economy Initiative at IIT Bombay for the research project titled “Skill Gaps and the Evolving Production Structure: Evidence from India’s Pharmaceutical Industry” for a total of 12 months (1st September 2025 to 31st August, 2026).

2. About NPEI

The New Political Economy Initiative (NPEI) is a research programme at IIT Bombay. The Initiative aims to rethink the study of the economy by catalysing a set of research collectives around key economic concerns. The Initiative draws together economists, political scientists, sociologists, historians, geographers, legal scholars, urbanists, technical experts, journalists and research practitioners to build a structural and institutional vision of South Asia’s economies, past, present, and future. We engage scholars from the above disciplines interested in studying the economy in four Research Clusters: Social Structures of the Economy, Regional Political Economy, Public Sphere and Public Goods, Industrial Policy and Structural Transformation.

The research project titled “Skill Gaps and the Evolving Production Structure: Evidence from India’s Pharmaceutical Industry” will be supported as part of the Industrial Policy and Structural Transformation (IP&ST) research cluster of NPEI.

3. Objectives of the proposed research project

The study would be divided into two phases (Phase 1 for 8 months and Phase 2 for 4 months) and will ask the following research questions:

- Is there a skill gap in the Pharma Industry? What is the nature and extent of the skill gap faced by enterprises?
- How does the skill gap affect enterprise performance and decision-making? Which strategic or operational choices are most constrained?
- What enterprise-specific characteristics—such as better retention rates, premium wages, employee benefits, or timely in-house training—help mitigate skill gaps within firms?
- Do enterprises that invest in skill development also exhibit distinguishing characteristics such as long-term commitment to the industry, technological sophistication, product complexity, market leadership ambitions, or efforts to move up the value chain? Conversely, are firms engaged in low-end, quality-insensitive production or driven by short-term, rent-seeking capital less likely to invest in skill development?
- Do firms that invest in standardized in-house training face higher worker attrition due to poaching, reflecting wage premiums, free-rider behavior, or moral hazard risks?

Please refer to the originally approved proposal, attached towards the end of this document, for details on the research project. The support and clearance for phase 2 will be incrementally approved after the results of phase 1 are presented.

4. Personnel composition

- Lead researcher(s): Irfan Ahmad Sofi (Islamic University of Science and Technology, Awantipora), Mukhtar Ahmad Sofi (Vellore Institute of Technology, Vellore) and VVS Rajendra Prasad (Vishnu Institute of Pharmaceutical Education and Research, Hyderabad)
- Point of contact from the NPEI team: Anush Kapadia, New Political Economy Initiative, IIT Bombay
- Thematic Mentor: Santosh Mehrotra (University of Bath)

The project, if required, will be having additional personnel support, the indication and magnitude of the same has been made in the next section.

5. Timeline of the project and support from NPEI for Phase 1

The proposed study will last for the duration of effect of these terms of reference i.e. starting from 1st September, 2025 through 30th April, 2026 (8 months), extendable to a full scale study for Phase 2 (for 4 months, extendable for 2 more months), upon review.

Timeline	Components of Phase 1
1st September - 31st October, 2025	Theoretical Conceptualisation & Literature review Project relevant hiring Questionnaire Formulation and training investigators
1st November, 2025 - 31st January, 2026	Enterprise Survey Pilot Data collection, entry, processing and associated field work Data analysis
1st February -31st March 2026	Data analysis and preparing the draft report
1st -30th April, 2026	Sharing interim findings and delivering the outputs Review of phase 1 and if approved, preparation for the next phase

Please note, all research studies supported by NPEI will have to undergo a mandatory review process, both internally and externally. The process will be coordinated by your point of contact. There will also be a mid-point progress presentation that the researchers are encouraged to schedule with the NPEI team.

The outcomes and the outputs (an interim report of the findings from Phase 1 and two public facing article contributions to NPEI blog space) will form the basis for the approvals for undertaking the 2nd phase of the study. At that point, these ToRs will be revisited. The lead researcher is requested to initiate this review in the final two months of the Phase 1 of the study.

Any publications (subsequent or interim) using the **material from the original study have to mandatorily acknowledge the financial support of the New Political Economy Initiative, IIT Bombay** by all the scholars involved, including any research assistants, associates, field investigators or

mentors. We do not want this research to be limited to academic journals and so after the completion of the term or each phase (as applicable), we would encourage the researchers to publish shorter analytical pieces on the NPEI website.

In case of any changes in the schedule, the researchers are required to be in touch with the designated point of contact.

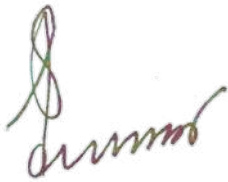
The support for this study would be as following

Budget head	Amount
Honorarium for Irfan Ahmad Sofi (Phase 1)	INR 200,000
Honorarium for Mukhtar Ahmad Sofi (Phase 1)	INR 180,000
Honorarium for VVS Rajendra Prasad (Phase 1)	INR 180,000
Honorarium for Santosh Mehrotra	INR 50,000
Honorarium for Research Assistant for 6 months	INR 270,000
Honorarium for 3 Field Surveyors for 4 months	INR 300,000
Field work support	INR 300,000
Research Resources	INR 100,000
Contingency	INR 50,000
Total	INR 1,630,000

6. Usage of allocated budget and terms of payment

- All personnel compensation will be made directly to the concerned individual's bank account.
- The honorarium payment for the lead researchers will be made in two installments. One, after the mid-point progress presentation and the second one after the submissions of the outputs of Phase 1.

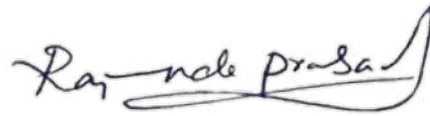
- The modalities of travel support and allowances (read “Field work support”) will be determined as per the guidelines from the Industrial Research and Consultancy Centre (IRCC) at IIT Bombay as the designated grant administrator.
- We strongly recommend a modest usage of funds and request the researchers to share their plan/itinerary for field work with office.npei@iitb.ac.in, at least 30 days before the scheduled travel. This will help our admin team to approve the budget and also coordinate with our travel desk for necessary bookings.
- Certain kinds of expenses can be undertaken directly by the researchers and can be claimed within 15 days as reimbursement. Reimbursement claims will be entertained against actuals upon submission of GST invoice and proof of payment. Unfortunately, cash payments cannot be reimbursed in this category of support, unless the mode of payment is clearly mentioned in the receipts.
- Under this support, NPEI cannot pay admin overheads to the parent institution of any researchers involved.



Irfan Ahmad Sofi



Mukhtar Ahmad Sofi



VVS Rajendra Prasad

In case of any queries in regards to these terms of reference, please get in touch with akapadia@iitb.ac.in and sonal.npei@iitb.ac.in. For any administrative and budget related matters, please keep office.npei@iitb.ac.in copied in all communications.

Attached: Original proposal for the study

Skill Gaps and the Evolving Production Structure: Evidence from India's Pharmaceutical Industry

Introduction

This research study is part of a three-industry study in the organized sector of India's manufacturing and services sector, with the objective of understanding how the employers in these three industries (IT/ITES, Drugs & Pharmaceuticals, Automobiles/Auto components) recruit appropriate workers, and suggest how their problems can be addressed. The overarching study is being conducted under the guidance of Prof. Santosh Mehrotra. Each proposal addresses a set of common as well as industry-specific questions, while also exploring distinct issues that are relevant to the broader objectives of the overarching study. A detailed justification for selecting the Pharma industry as the focus of this particular research is provided below.

The pharmaceutical industry is one of the three industry sectors chosen for this multi-industry research project. This is a crucial sector in India, contributing significantly to economic growth, with CAGR of 9.43% over the last nine years while adding over 11.88 billion exports (GOI, 2023). India is the largest provider of generic medicines globally, supplying about 20% of global demand in terms of volume. As of 2023, the Indian pharmaceutical market was valued at around USD 50 billion, and is expected to reach USD 130 billion by 2030. There are over 3000 drug companies and 10,000 manufacturing units in the country. The Pharma exports have increased from \$5.9b in 2008 to \$11.8 billion in 2022 and now \$30 billion in 2025.

However, the Indian Pharmaceutical sector is facing multiple challenges. First, it is facing a high dependence on Chinese imports especially for Active Pharmaceutical Ingredients (APIs). The APIs of 378 of 699 drugs were imported from China (Joseph & Kumar, 2021). A drug security committee of GOI in 2020 found that India was 100% dependent on China for at least 45 APIs (Chaudhuri, 2021). Overall import dependence is 11% of production – 40% in bulk drug segment & 5% in formulations. It is observed that the export growth in products where India depends on Chinese APIs has been lower. Chinese dependence is threatening the sustainability of growth in India's pharmaceutical industry, as China is increasingly capturing the international market. Chinese share in global export of formulations or generic drug market has grown at a compound annual growth rate of 15% compared to 11% of India between 2009 to 2018.

Second, with its rapid expansion, technological evolution, and increasing global competition, the need for a highly skilled workforce has become paramount. Several recent reports of both government and private agencies highlight a growing skill shortage in the pharmaceutical sector. According to the *Skill India Report 2021*, the industry is grappling with a serious skill gap, with 63% of graduates from pharmaceutical education programs deemed unemployable due to inadequate skills. Among the 14 domains discussed in the Skill India Report 2011, the youth population in pharma domain ranked among the five lowest in terms of employability, with its

employability rate remaining 9 percentage points below the average (SIR, 2021). Similarly, a recent report by the National Skill Development Corporation (NSDC) covering the period 2017–2022 reveals that nearly 50% of workers in the chemicals and pharmaceutical sector have only completed up to the 12th standard or lack technical/vocational training. Only 5–8% of workers hold postgraduate qualifications. Third, the NSDC report also notes that a significant share of the sector's workforce operates in the informal or unorganized segment— this finding is also corroborated by Annual Survey of Industries (ASI) data. The issues of poor compliance of quality standards in pharma sector as highlighted by several reports can be linked to skill deficiency and informal labour practices (Deloitte India Survey, 2015; Express Pharma, 2017).

Furthermore, the *Skill Requirement Assessment Study 2022* by the Department of Pharmaceuticals (Ministry of Chemicals and Fertilizers, Government of India) highlights the poor state of on-campus training in the pharmaceutical sector. Only 57% of companies offer internships to students, and of these, 85% tend to hire from among their own interns—underscoring the critical importance of job-specific skills in the sector.

These skill gaps not only affect the quality of production but also weaken the upper segments of the pharmaceutical value chain, particularly Research and Development (R&D) and innovation culture. According to NSDC reports, only a few Indian pharmaceutical companies possess robust R&D pipelines. Despite being a leading global supplier of generic medicines, the average R&D intensity in Indian pharmaceutical industry remains significantly lower (5.8%) compared to its global counterparts (17.3%) (Fast India, 2024).

Evolving Production Structure, Import Dependence and Skill Demand

India's Pharma sector has historically operated under *cost-based price control system in which govt calculated drug's max. retail prices, which included cost of production and a profit margin*. In 1970s, 100% of the drugs were under price control system, which came down to 50% in 1995. While such system assured a predefined rate of return, it *discouraged investments in innovation and R&D* (5.3% compared to 17.3% global average), thereby *affecting core manufacturing capabilities* (Joseph, 2012). China produced APIs at cheaper rates – with 35-40% cheaper as compared to production costs in India (Bart, Aggarwal, and Singh, 2013; KPMG-CII, 2020). The cheaper API imports from China induced Indian firms to focus on formulations. And over time, as the export-orientation of our firms increased – from *15% of total sales in 1994 to 41% in 2010 (%share of formulations is 78%)*, our dependence on Chinese cheaper API imports increased. Further, India's IPR regime during 1970-2005 provided process patents only, encouraging reverse engineering and production of generic versions of patented drugs – another reason why firms focused on formulations.

Formulations segment is less capital intensive and involves less complex operations/less automation. And it is usually dominated by small and medium sized firms. The focus on

formulations and the import dependent production structure resulted in an increased demand for low level skills, shaping the overall ecosystem accordingly and inducing informal labour practices. *However, after TRIPS agreement in 2005*, India granted product patents, which forced firms to make a shift from copying to innovations and R&D for survival in the long-run. This motivated a push for investments in capacity building, and high level skills. Digitalization in the recent years has created more demand for high skilled workers. In the wake of above, the central govt. introduced *Pharmaceutical Policy 2017 and PLI scheme 2020 aim to promote self reliance in bulk drugs/API, encourage R&D, new drug development, expansion in operational scale.*

Recent Policy Initiatives

The central government introduced several policy initiatives to address skilling challenges and give boost to the formal manufacturing sector. The government established National Skills Qualification Framework (NSQF) in 2013 – to facilitate competency-based standardized skill development. It also Established Life Sciences Sector Skill Development Council (LSSDC) 2014 under NSDC to address skill needs of Pharmaceuticals, biotech., and clinical research. It facilitates industry-academia linkages by defining NOS, QPs, while also dealing with curriculum/assessment/certification, & overseas Skill India Mission/PMKVY.

Firms have two sources for skills: pre-employment institutional training and on-the-job training. However, in India, firms mostly rely on pre-employment (institutional) training for their skill requirements. As far as On-the-job training is concerned, only 20 per cent of all Indian firms are providing any form of training to their employees Mehrotra (2014).

Previous literature suggests that a host of factors are responsible for poor on-the-job training practices in India, including free rider and moral hazard problems (Mehrotra and Ghosh, 2014), Labour Regulations (Dougherty et al., 2013), Contractualisation of workforce (Sofi, 2022), and financial constraints (Konings & Vanormelingen, 2015), among others. However, the status, determinants, and dynamics of pre- and on-the-job training in the Indian pharmaceutical sector remain relatively underexplored.

India's pharmaceutical industry (like most other industries) is characterized by a dual labour market structure, where contract workers are hired alongside regular workers even for core business activities (Sofi and Kunroo, 2018). As per the Annual surveys of Industries, the share of contract workers has increased from 26% in 2008 to 38% in 2021. The contractualisation of labour is associated with labour laws, among other factor (Sapkal, 2016). While this strategy provides firms with greater flexibility in managing labor costs, it also raises critical questions regarding investment in human capital development (Kapoor, 2014). Firms may be reluctant to invest in training contract workers due to their short tenure, leading to disparities in skill development between regular and contract employees. Understanding the extent to which contractualization affects on-the-job training is essential for assessing its long-term implications on productivity and workforce stability.

Within the above backdrop, this study broadly aims to investigate the following research questions.

Research Questions

- Is there a skill gap in Pharma Industry? What is the nature and extent of the skill gap faced by enterprises?
- How does the skill gap affect enterprise performance and decision-making? Which strategic or operational choices are most constrained?
- What enterprise-specific characteristics—such as better retention rates, premium wages, employee benefits, or timely in-house training—help mitigate skill gaps within firms?
- Do enterprises that invest in skill development also exhibit distinguishing characteristics such as long-term commitment to the industry, technological sophistication, product complexity, market leadership ambitions, or efforts to move up the value chain? Conversely, are firms engaged in low-end, quality-insensitive production or driven by short-term, rent-seeking capital less likely to invest in skill development?
- Do firms that invest in standardized in-house training face higher worker attrition due to poaching, reflecting wage premiums, free-rider behavior, or moral hazard risks?

Literature Review

Training has long been recognized as a crucial component of workforce skill development and productivity enhancement (Sarkar, 2020). Various studies highlight the role of OJT in improving firm efficiency, employee performance, and industrial competitiveness (Jain & Jain, 2016; Truitt, 2011; Lindsley, 1998). This section reviews existing literature on the significance of training, its determinants, and how labour dynamics, particularly contract labour and caste-based segmentation, influence its implementation in the Indian pharmaceutical sector.

Becker's (1964) human capital theory posits that investments in training, whether general or specific, enhance workers' productivity and firms' overall efficiency. Numerous studies (Bartel, 1995; Zwick, 2006) have found positive correlations between training and firm performance, particularly in skill-intensive industries. In pharmaceutical manufacturing sector, stringent quality control, safety regulations, and rapid technological advancements often necessitate continuous skill upgrading (Chatterjee & Sarkar, 2020). Therefore, OJT plays a vital role in maintaining competitiveness (Lall, 2000).

Research indicates that several factors influence firms' decisions to invest in OJT. These include firm size, capital intensity, regulatory requirements, and workforce composition (Besley & Burgess, 2004; Dougherty et al., 2013; Sofi & Kunroo, 2018). Larger firms with more resources are more likely to invest in structured training programs, whereas smaller firms may struggle due to financial constraints (Konings & Vanormelingen, 2015). Mehrotra and Ghosh (2014) argue that despite the significant importance of on-the-job training in firm performance, India firms do

not invest enough resource on it due moral hazard and free-rider problems leading to market failures.

Free Rider Problem

The study will also examine the free rider/moral hazard problem in the context of firms' investments on skill development. Free rider problem arises when firms poach trained employees of their rival firms. If one firm trains workers, another firm may poach them without incurring training costs. The employee poaching can discourage firms to invest on skill training, as employers become reluctant knowing they might lose their trained workers to competitors (Leuven 2005). This problem becomes serious in case of general skills, which are transferable across firms. The incidence of poaching may be influenced by a range of factors, including information asymmetry and visibility of the employee training to rival firms.

Firms usually offer training through apprenticeships/internships and they often remain in a better position to learn about the productivity of their apprentices/interns as compared to other non-training firms (Mohrenweiser et al. 2013). Therefore, in imperfect labour markets, the training firms often have higher motivation to retain productive/trained apprentices or employees, and they can offer higher wages than their rivals – since non-training firms remain unaware of true productivity of trained employees. However, if the skill training of a worker and its quality is visible to rival non-training firms, the risk of poaching increases. Thus, there is a trade off between training quality/visibility and poaching risk. Free riders can use formal training certificates and grades of trained employees as proxies for high productivity, and thus poach skilled workers of training firms by offering higher wages. The visibility of training for rival firms can become easier when firms are required to strictly follow a standard qualifications framework such as the NSQF. The institutional requirements may also increase the transferability of skills by limiting firm's freedom to customize the general content as per the company requirements. The free riding problem is likely to vary across different contexts, depending upon the density of the local labour markets, with more dense labour markets facing higher poaching threats (Muhlemann and Wolter, 2011). One way of ensuring high employee retention or discouraging job separation is the use of efficiency wages – a wage rate that is higher than the prevailing market wage – which is intended to make job switching less attractive. However, efficiency wages may reduce the net benefits of training investments, leading to sub-optimal levels of training.

Non-compete Agreements

Another alternative tools being widely used across countries to tackle the employee poaching problem are legal contracts. Companies across the world employ various contractual mechanisms such as non-compete agreements, non-poaching agreements, and confidentiality covenants are employed to mitigate these risks. Non-compete agreements, which are signed between firms and

employees, are aimed to restrict the employee's ability to join a competitor post-employment. These agreements intend to safeguard firms' investment in human capital and proprietary knowledge.

Experiences of Other Countries with Non-compete Agreements

Non-compete agreements accounts for 18% of workers in the United States, and they remain clustered in high-skill sectors (Starr, Prescott, and Bishara, 2021). A U.S. based study shows that non-compete agreements are associated with nearly 12 % increase in job tenure (Lavetti, Simon, and White, 2020). Notably, 40% of U.S. non-compete signed workers declined competitor offers due to these agreements, even in states where enforceability is low (Starr et al., 2021). Further, Kang & Fleming (2020) report that firms in states with high enforcement of non-compete agreements saw a faster increase in the number of establishment units, though such agreements affected new entrants in the market.

In China, non-compete agreements are legally enforceable for up to two years post-termination, but only for senior management, technical staff, or those with confidentiality obligations (Choi et al. 2024). There has been a notable rise in the enforcement of non-compete agreements in China. Chinese courts have ruled in favour of employers in multiple cases in recent years, such as Tianjin Case and Jiangsu Case, and Suzhou Case (Choi et al. 2024). For example, in the Suzhou Case, the court ruled to stop a former employer from working with a competitor for the non-compete post-employment period (during the litigation) to protect the interest of the former employer.

However, critiques of the non-competes argue that these agreements disproportionately affect young firms, and vulnerable workers due to their limited bargaining power (Starr, 2019). It is also argued that if companies misuse non-compete agreements, they can reduce labor mobility and suppress wage growth, thereby affecting the overall labour market dynamics and innovation culture (Starr, 2014).

However, recently, Singapore and the U.S. have scrutinized these agreements. Singapore's Competition Act (2004) explicitly prohibits non-poaching agreements under Section 34, and courts have penalized firms for such collusion. In the United States, the Department of Justice dismantled no-poach pacts among six major Silicon Valley tech firms in 2010 and has since pursued criminal indictments in similar cases (Norlander, 2024). Similarly, the Federal Trade Commission of the United States (FTC) announced regulations banning non-compete in April 2024 to promote competition, protect employees' job mobility, foster innovation, and encourage new business forms. However, recent court decisions in various states have prevented the FTC from enforcing the ban (Choi et al. 2024)

In India, post-employment restraints such as non-compete clauses are generally unenforceable under Section 27 of the Indian Contract Act, 1872. Courts have consistently upheld employees'

rights to seek better employment opportunities. In *American Express Bank Ltd. v. Ms. Priya Puri*, the Delhi High Court refused to enforce a post-employment restriction, citing the importance of intellectual and professional freedom. Similarly, in *Pepsi Foods Ltd. & Ors. v. Bharat Coca-Cola Holdings Pvt. Ltd. & Ors.*, the court rejected post-termination restraints, warning against creating conditions akin to 'bonded labour.' In *Desiccant Rotors International Pvt. Ltd. v. Bappaditya Sarkar*, Delhi court observed that employer's attempt to seek protection against competition through non-compete agreement clashes with employee right to seek employment as per will. Similarly, the Bombay High Court echoed this view in *Jet Airways (I) Ltd. v. Mr. Jan Peter Ravi Karnik*, emphasizing the constitutional right to livelihood.

Thus, while legal tools such as non-compete and non-poach agreements can address the risk of free-riding in training, their validity has come under scrutiny due to their negative effect on individual freedom, labour market competition, workers' bargaining power and entry of new firms.

Against this backdrop, the present study aims to examine these issues in Indian context and explore alternative, equitable mechanisms to address skilling challenges in contexts where legal tools like non-compete and non-poach agreements face legitimate criticism and legal uncertainty. Specifically, the project will examine the potential of collective action and Reimbursable Industry Contribution (RIC) models as viable solutions to mitigate free-rider problems, promoting a competitive labour market and addressing industries' skill shortages.

Contractualisation of employment and Free Rider Problem

The free riding problem is likely to be exacerbated by the growing trend towards contractualisation of employment. Due to their short-term employee commitments, contract workers usually keep on switching across companies and they prefer to invest in general skills to enhance their transferability across firms rather than showing interest in company specific skill development (MacLeod and Navakachara 2007). These issues further dissuade employers to invest on training of contract workers, reinforcing a vicious cycle of skill poverty.

The increasing reliance on contract labour in India raises concerns about firms' incentives to invest in training. Studies suggest that temporary or contract workers receive less training than permanent employees due to high turnover rates and uncertain employment tenures (Autor, 2001; Sapkal, 2016). In the pharmaceutical industry, where knowledge retention and skill accumulation are critical, this disparity in training investment can have long-term productivity implications (Goldar & Aggarwal, 2012; Sofi et al., 2022).

Role of Regulations

Skill training practices can be influenced by multiple other factors such as technological changes including digitalization, changing labour dynamics, regulations, among others. This study, in addition to analysing the impact of informalization/contractualisation on skill training practices, will attempt to discuss the impact of regulations and other emerging trends such as digitalization on skilling challenges.

Different types of regulations and government policies can influence skill development practices both at the supply side and on-the job, such as (a) labour laws (e.g. Industrial Disputes Act, 1947; Factories Act 1948; Apprentices Act 1961) (b) Environmental and safety regulations (e.g. Environmental Protection Act, 1968), (c) Regulatory requirements specific to pharmaceutical industry, and (d) government skill development policies such as Pradhan Mantri Kaushal Vikas Yojana (PMKVY).

For example, firms coming under chapter 5B of the Industrial Disputes Act (IDA) 1947 (applicable for firms with 100 or more workers) are required to follow a range of dismissal laws/job security laws – these laws are not applicable to contract workers. While job security laws can make labour adjustments difficult (Dougherty et al. 2013), they can increase retention rates and enhance workforce stability, which can in turn encourage investments on firm-specific skill development at the workplace (Macleod and Navakachara, 2007). Thus, theoretically, it can be hypothesized that larger firms (which come under chapter 5b of IDA) and with greater intensity of regular workforce are likely to have better on-the-job training practices. However, previous literature from India argues that firms replace regular workers with contract labour to evade labour laws (Kapoor, 2014) and save wage bills – contract workers face significant wage differential (Sofi and Sharma, 2015). This practice may bring short-run savings in wage bills (due to cheaper availability of contract labour), but it can discourage investments on firm-specific skills due to a lack of long-run term employee commitments and principal agent problem (Ross, 1973), thereby hurting firm productivity. Similarly, stricter employment protection laws can lead to non-cooperation or reduced motivation among workers to actively participate in skill enhancement or upskilling programs. When job security is guaranteed regardless of performance or skill levels, workers may feel less pressure to update their skills or adapt to new technologies. This can result in complacency, especially among permanent employees who perceive limited risk of job loss. Over time, such attitudes can weaken the overall effectiveness of workplace training initiatives and slow down the pace of technological adaptation and productivity growth within firms (Wasmer, 2002).

Thus, labour regulations can have both positive and negative effects on on-the job training, depending on whether firms choose to leverage it for making efficiency gains or they seek to evade it by replacing regular workforce by non-regular labour. Similarly, we can theoretically underpin the role of other types of regulations and incorporate it in our study.

It is worth noting that the Principal Investigator has a strong command of the literature on labor market regulations, as demonstrated by his publications (detailed in the attached CV). This

expertise positions the team well to effectively incorporate the regulatory dimension into the proposed study.

Skilling Challenges emerging from digitalization

This study will also attempt to explore the specific skill challenges facing/associated with the digitalization in the pharma industry and how these challenges can be addressed collectively at various levels of the skill ecosystem.

As per the Skill Assessment Requirement Study of the Department of Pharmaceuticals (Ministry of Chemicals and Fertilizers), Process automation and digitalization has been cited by pharma companies as one of the nine important futuristic technological adoptions in India. In a similarly vein, the Future of Jobs Report 2018 indicates that more than 50% of the workforce would need reskilling in the wake of technological advancements and evolving nature of jobs. According a study conducted by the GlobalData, 49% of companies in Pharma industry believe that their digital transformation is hindered by specific skill shortages.

Digitalization involves use of automation, data analytics, AI & ML, and ERP systems, among others. Managing these systems can be challenging for the large chunk of the workforce, calling for timely re-skilling interventions and updating of curriculum in colleges and training centres as per industry requirements.

Methods and Sampling Design (Phase 1)

The study will be conducted in two phase. A pilot study will be carried out in the first phase, which will be followed by the full scale study. To achieve the research objectives, a structured sampling design will be implemented to select a representative sample in Hyderabad, ensuring methodologically rigorous approach. Hyderabad hosts one of the world's largest integrated pharmaceutical clusters. The specific feature of pharmaceutical clusters in Hyderabad is their special focus on both R&D and manufacturing (DoP, 2023), making it an ideal location for studying the skill development across the entire skill ecosystem – encompassing both the supply and demand sides.

The target population for this study consists of pharmaceutical enterprises operating in two Pharma Clusters in Hyderabad (Jeedimetla and Turkapally), hosting about 320 industrial business units with total output capacity of 24000 tonnes (GoI, 2023). However, as per the list

obtained from PharmaDinfo.com, only about 230 registered enterprises are identified. We will select only enterprises that are formally registered under the Factories Act, 1948.

Sample Size (Phase 1)

In phase 1 (pilot phase), the study will be restricted to 50 to 100 enterprises, which will be randomly selected for the population¹. Considering the nature of this study and the total population, the sample size of 50 to 100 enterprises is expected to provide sufficient statistical power for meaningful analysis while maintaining feasibility within the scope of the research.

The study will employ a combination of stratified random sampling method and purposive sampling for selecting enterprises from different enterprise groups (including small, medium and large enterprises, factoring in other firm characteristics such as indigenous/foreign and API and formulations oriented firms).

We will also attempt to incorporate other forms of the firm structure in the sampling design such as the degree of vertical and horizontal integration, which affect skill requirements. The training/requirements in vertically integrated enterprises dealing with multiple stages of the value chain are likely to be different than horizontally integrated firms, which operate across similar stages of the value chain. The sampling procedure will involve the following steps:

A comprehensive list of pharmaceutical enterprises registered under the Factories Act, 1948, in Hyderabad will be obtained from relevant organization in Hyderabad. In fact, a list of registered enterprises in Hyderabad from PharmaD Info.com has already been obtained. A fixed sampling interval (k) will be calculated based on the total number of registered enterprises (given in the enterprises list) and the required sample size (50-100). A random starting point will be selected, and every k -th enterprise will be chosen for the study from each strata. By using systematic random sampling, the study ensures that all enterprises have an equal probability of selection, reducing selection bias in each strata of the population. The study will also make use of national level micro-databases including annual surveys of industries (ASI) and other national surveys for adding empirical rigor in the study.

The study will rely on both descriptive analysis and regression analysis. Descriptive analysis will be particularly used in analyzing patterns and distributions, while regression analysis will be used to examine causal relationships. Further, for deeper understanding of the nature of issues and problems facing pharma firms in accessing skilled workforce, we will conduct in-depth interviews with key stakeholders. The key stakeholders in the in-depth interviews will include HR managers, and employees (both regular and contract workers), educational institutions, among others.

¹ We are open to making adjustments in sample size. The sample size can be discussed further.

Policy Relevance

Skill gaps are indeed not static or permanent. However, analysing their nature and persistence remains crucial especially in pharmaceutical industry, which is undergoing structural transformation amidst intense global competition. A deeper understanding of nature and extent of skill gaps, the role of emerging trends (such as changing production structures, free rider problem, digitalization, and contract labour use) in shaping the skill challenges is vital for ensuring timely policy interventions to align the skill ecosystem with evolving industry requirements. Proactive policy interventions can accelerate the resolution of these issues, enabling firms to tap into high-value international markets more swiftly.

By addressing these objectives, this research intends to contribute to the ongoing discourse on workforce development in India's pharmaceutical industry and offer policy recommendations for enhancing skill formation in the sector. The study will be particular of importance for the Life Sciences Sector Skill Development Council (LSSSDC), the Department of Pharmaceuticals (GOI), and other policy makers for understanding nuances of the skill problems in this sector and their possible solutions.

Feasibility

The research team has several connections in Hyderabad, both at pharma training institutes and at the pharmaceutical companies. To strengthen our connections and collaborative framework, we have roped in two Co-Principal Investigators based in Hyderabad, Dr. V.V.S. Rajendra Prasad, Professor at Vishnu Institute of Pharmaceutical Education and Research (VIPER), BVRIT, Hyderabad, and Dr. Mukhtar Sofi, VIT, Vellore.

Dr. Prasad and the Institute (VIPER) has collaborations/connections with several pharma companies in Hyderabad and many of its alumni are working in these companies. Besides, he brings expertise in Pharmaceutical education, which is advantageous for the project. Similarly, Dr. Mukhtar Sofi has more connections with the stakeholders in Hyderabad. Dr. Mukhtar brings expertise in information technology and computer science.

The PI of this project has already done 5 funded projects (from government and private organizations including two projects from ICSSR New Delhi, one project from Azim Premji University, one from National Commission for Women, and one from South Asia Research Network). Moreover, three of his previous projects involved primary data collection from households, entrepreneurs, and firms with large samples.

Further, the PI has a strong command of the literature on labour and industry studies as demonstrated by his publications (detailed in the attached CV). This expertise positions the team well to effectively incorporate the regulatory dimensions into the proposed study. Additionally,

the PI has a significant experience of handling unit-level/plant-level national datasets such as Annual Surveys of Industries (ASI), National Sample Surveys (NSS), and Consumer Pyramids Household Surveys (CPHS), enabling the team to leverage such expertise for supplementing the empirical rigor of the study.

The study will be carried out under the mentorship and guidance of Prof. Santosh Mehrotra, whose extensive expertise and vision will be instrumental in shaping the research design, ensuring academic rigor, and guiding the team toward meaningful policy insights.

Duration of the Project (Pilot Phase): 9 months.

Duration (Second phase/full scale): 6 months.

Total duration (pilot + full scale): 15 months.

Breakup of timelines and milestones (Pilot Phase):

S.No.	Milestones	Outcomes	Timelines	No. of months
1	<i>Theoretical Conceptualization & Questionnaire Development</i>	Final Questionnaire	1 st August 2025 to 30 September 2025	2 months
2	Pilot Survey	Filled Geo-tagged Questionnaires	1 st October 2025 to 31 December 2025	3 months
3	<i>Data Entry, Processing, and Data Analysis</i>	Data Files (in Excel and STATA format)	1 st January 2026 to 31 st January 2026	1 month
4	<i>Report Writing</i>	<ul style="list-style-type: none"> Project Report Draft research paper 	1 st February 2026 to 30 February 2026	1 month
5	<i>Seminar and Dissemination</i>	<ul style="list-style-type: none"> Seminar for the presentation of research findings. Publication of articles in national newspapers (such as The Hindu). 	1 st March 2026 to 31 st March 2026.	1 month

		<ul style="list-style-type: none"> Submission of research article to peer-reviewed journal (such as Journal of Development of Economics or EPW) 		
6	Total			8 months

Financial Implications (First phase):

S.No.	Budget Head	No.	Duration
A. Research Staff			
1	Research Assistant	1	8 months
2	Field Investigators	3	6 months
3	Principal Investigator	1	3 hours per day for 62 days
4	Project Advisor/Mentor	1	1 hour per day for 30 days
5	Co-Principal Investigator	1	1 hour per day for 30 days
Field Work			
6	Accommodation for Field Investigators during field work	3	90 days
7	Food for Field Investigators during field work	3	90 days
8	Travel for Field Investigators during field work	3	90 days
9	Travel, accommodation, and food for Research Team Members for stakeholder engagement/dissemination/presentations for field work	3	10 days
C. Equipment			
10	Equipment (Tab)	1	--
D. Dissemination			

11	<ul style="list-style-type: none"> ● Seminar (honorarium, food, accommodation, travel, stationary). 	1	2 days
E. Contingencies			
12	Contingencies	--	--
F. Data subscription and Study Material			
Overhead Charges			
14	Institutional Overhead	1	7-10%

Deliverables

1. Final Project Report
2. Journal Publication
3. Policy Briefs
4. News Paper Articles

Bio of Research Team Leaders

Prof. Santosh Mehrotra (Advisor/Mentor)

Prof. Mehrotra is a renowned labour and development economist, with national and international reputation. He held a professor position at JNU, New Delhi and served as Head of the ICMR division of the Planning Commission of India (now NITI Aayog). He has published more than 100 research articles and 11 books with national and international reputed publishers.

Dr. Irfan Ahmad Sofi (Principal Investigator)

Dr. Sofi works as Assistant Professor of Economics at the Islamic University of Science and Technology (IUST), Awantipora, Jammu and Kashmir. He earned his Ph.D. in Economics from IIT Indore and a post-doctorate from IIT Guwahati. His areas of research interest include labour and industry, and development economics. He has published his research in reputed journals like International Labour Review, Economic and Political Weekly (accepted), Journal of Quantitative Economics, Margin, International Journal of Social Economics, Empirica, among others. Dr. Sofi has received 2 major research grants from ICSSR, 1 major grant from Azim Premji University, and 1 major grant from National Commission for Women, New Delhi for his research projects. He also won the Labour Economics Award for Young South Asian Scholars, from SARNET and IHD (New Delhi). He has contributed several research-based articles to The Hindu. His detailed CV is attached.

Dr. Mukhtar Ahmad Sofi (Co-Principal Investigator)

Dr. Mukhtar is a Computer Scientist. He works as Assistant Professor at Vellore Institute of Technology, Vellore. He has published several researches in international journals, and has recently co-authored a book with Springer. He has good command over Deep Learning and Data mining tools. Dr. Mukhtar will contribute to this project in terms of his assistance in secondary data extraction from large national datasets and he will play an important role in stakeholder engagement in Hyderabad, besides monitoring field-work related activities along with Principal Investigator.

Dr. V.V.S. Rajendra Prasad (Co-Principal Investigator)

Dr. Rajendra Prasad is Professor at Vishnu Institute of Pharmaceutical Education and Research (VIPER), Hyderabad and Dean (Research) at BVRIT, Hyderabad. With over 21 years of academic and research experience in pharmaceutical sciences, he has served as Principal Investigator for multiple government-funded projects from DST, ICMR, DBT, AICTE, and MSME. His pharmaceutical research focuses on drug discovery, overcoming multidrug resistance in cancer, targeted drug delivery systems, and biosensor development. Dr. Prasad has published extensively in reputed journals and has presented his pharmaceutical research at international forums in Boston and Paris.