# SOCIO ECONOMIC ANALYSIS OF RESERVATIONS IN ENGINEERING EDUCATION IN DELHI

**A Thesis**

*Submitted to*
*Department of Humanities*
*In the partial fulfilment of the requirement of the degree of*
**Doctor of Philosophy**

**By**

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## DECLARATION

I hereby declare that the research work presented in this thesis entitled " **Socio Economic Analysis of Reservations in Engineering Education in Delhi**" is original and carried out by me under the supervision of Prof. Seema Singh, Professor, Department of Humanities, Delhi Technological University, Delhi, and being submitted for the award of Ph.D. degree to Delhi Technological University, Delhi, India. The content of this thesis has not been submitted either in part or whole to any other university or institute for the award of any degree.

**Date:** 30/05/2024
**Place:** DTU, Delhi.

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## CERTIFICATE

This is to certify that the PhD thesis entitled "**Socio Economic Analysis of Reservations in Engineering Education in Delhi**" is being submitted by Mrs. Itishree Choudhury, for the fulfilment of the requirements for the award of the degree of Doctor of Philosophy in Economics to the Department of Humanities, Delhi Technological University, Delhi, India. She has a bona fide record of original research work carried out by her under my guidance and supervision. The results embodied in this thesis have not been submitted to any other university or institution for the award of any degree.

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## LIST OF PRESENTATION IN CONFERENCES

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## ABSTRACT

The societal development requires deliberate and effective restructuring of social frameworks within economic contexts. Historically, marginalized segments of society in India, including Scheduled Tribes (STs), Scheduled Castes (SCs), Other Backward Classes (OBCs), religious minorities, and women, have endured systematic exclusion from developmental opportunities, resulting in enduring disparities. Recognizing this, the Government of India has acknowledged the persistent need to uplift marginalized communities through affirmative action. Specifically, the government introduced reservation policies in educational institutions for socially backward castes (SCs, STs, and OBCs), permitting religious minorities to establish educational institutions, and looking at the cultural aspect, establishment of educational institutions only for women, aimed at improving their socio-economic and educational circumstances. However, implementing such policies, particularly in higher education institutions, has given rise to extensive debate due to its growing impact on the changing socio-economic aspects of the community. In this context, it is important to understand the effectiveness of affirmative action on access, equity, and outcomes in higher education, particularly in engineering education. Higher and technical education, including engineering, is widely acknowledged as crucial for community empowerment and advancement, producing dynamic capabilities among youth. Despite several studies examining the effects of reservation policies in education across India (Weisskopf, 2004; Cho, 2014; Basu, 2021; Ahmad, 2022), research specific to engineering and technical education remains limited. Thus, there is a pressing need for a comprehensive socio-economic analysis focusing on reservations and affirmative actions in engineering education to assess its effectiveness on marginalised or disadvantaged groups and identify areas for improvement. This study, focusing on social groups/castes (SC, ST and OBC), religious minorities, and gender, examines the inequalities in access to engineering education, their academic performance, and labour market outcomes in Delhi, India. The specific objectives of the study are as follows:

i. To discuss all affirmative programmes offered by degree level engineering institutions in Delhi.
ii. To investigate the socio-demographic and economic status of the Scheduled Caste (SC), Scheduled Tribe (ST), and Other Backward Classes (OBC), Religious Minorities and Male versus Female.

iii. To analyse and compare the academic performance, placement and earnings among SC, ST and OBC engineering students.
iv. To analyse and compare the academic performance, placement and earnings among religious minority students in engineering education.
v. To analyse and compare the academic performance, placement and earnings of female engineering students with their male counterparts.

Institutional and student questionnaires were used as survey tools to analyse these objectives. Data was collected from 18 engineering institutes in Delhi (13 government and 5 private) during the academic year 2018-19. Among 18 institutions, 3 minority institutes offer specific reservations for religious minorities and one institution exclusively for female candidates. For the student questionnaire, altogether, there are 3186 respondents, which are divided into two groups: socially backward caste students, and religious minority students. The analysis includes 2288 respondents from socially backward castes (SC, ST, and OBC) and 898 respondents from religious minority groups. Furthermore, gender-based analysis has been conducted by combining both groups. All the respondents are B-Tech fourth-year students who were purposefully surveyed to collect information about their academic and placement experiences. The first two objectives were discussed through descriptive statistics, and the rest were discussed through inferential statistics.

The study delves into various affirmative actions, including reservation policies, aiming to promote equal opportunities. Also, the study examines the socio-demographic and economic backgrounds of students benefiting from reservations and their subsequent academic performance and labour market outcomes. The discussion about socio-demographic and economic background highlights the influence of family and economic factors on educational pursuits, suggesting that urban families may have better access to information and resources for engineering education. Furthermore, the association of parental education, occupation, and family income in determining enrolment in engineering education are emphasised.

Additionally, findings reveal disparities in academic and labour market outcomes among different social groups under study. OBC students exhibit better academic performance, placements and earnings than their SC and ST counterparts. The academic performance of SC/ST students is about 38 per cent lower than that of OBC students, with SC and ST engineering students receiving fewer job offers and lower salaries than their OBC counterparts.

This highlights disparities in academic and labour market outcomes among socially backward castes. Among religious minorities, Muslim students demonstrate substantial academic performance gaps, with their academic performance being around 71.4% lower than that of other minority students. Interestingly, Muslim students are 6% more likely to get job offers than their counterparts from other minority groups, although their earnings are almost 40% less. These results underline the presence of differences among minorities in both academic performance and the job market. Gender disparities are evident, with male students outperforming females academically, but females have more employment opportunities. Better employment opportunities for females here may result from changes in the labour market and policies within the country. Companies aiming to maintain the gender ratio in the workforce may prioritise hiring females due to their low representation in this field. However, male engineering students earn about 7% more than their female counterparts, indicating gender-based wage disparity again favouring males. This disparity may arise from employers perceiving males as more productive, resulting in higher salaries for male engineers having better negotiating skills. Here, female graduates face discrimination in terms of academic performance and earnings.

Overall, findings of the study suggest for the effective implementation of reservation policies to address disparities and enhance inclusiveness in engineering education. The findings are valuable addition to the growing literature on reservations in higher education and provide evidence-based insights for policymakers and educational institutions to improve the effectiveness and inclusivity of reservation policies.

**Keywords:** Reservations, Engineering education, Socio-economic analysis, Academic performance, Placement, Earnings

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| Acronym | Full Form |
|---|---|
| ADGITM | Dr. Akhilesh Das Gupta Institute of Technology & Management |
| AIACTR | Ambedkar Institute of Advanced Communication Technologies and Research |
| AICTE | All India Council for Technical Education |
| AISHE | All India Survey on Higher Education |
| BPIT | Bhagwan Parshuram Institute of Technology |
| BVCE | Bharati Vidyapeeth's College of Engineering |
| CBPGEC | Ch. Brahm Prakash Government Engineering College |
| DASA | Direct Admission of Students Abroad |
| DITE | Delhi Institute of Tool Engineering |
| DTU | Delhi Technological University |
| EWS | Economically Weaker Sections |
| GBPGEC | G.B. Pant Government Engineering College |
| GTBIT | Guru Tegh Bahadur Institute of Technology |
| HEIs | Higher Education Institutions |
| HMRITM | HMR Institute of Technology and Management |
| IGDTUW | Indira Gandhi Delhi Technical University for Women |
| IIDS | Institute of Dalit Studies |
| IIIT | Indraprastha Institute of Information Technology |
| IIT | Indian Institutes of Technology |
| JH | Jamia Hamdard |
| JMI | Jamia Millia Islamia |
| MAIT | Maharaja Agrasen Institute of Technology |
| MHRD | Ministry of Human Resource Development |
| MSIT | Maharaja Surajmal Institute of Technology |
| NCMEI | National Commission for Minority Educational Institutions |
| NEP | National Education Policy |
| NIT | National Institute of Technology |
| NPTI | National Power Training Institute |
| NSSO | National Sample Survey Office |
| NSUT | Netaji Subhas University of Technology |

| | |
|---|---|
| OBC | Other Backward Classes |
| SC | Scheduled Castes |
| ST | Scheduled Tribes |
| STEM | Science, Technology, Engineering, and Mathematics |
| UGC | University Grants Commission |

# CHAPTER 1
# INTRODUCTION

## 1.1. Background

Higher education plays a crucial role in the personal, professional, and social development of individuals (Kromydas, 2017; Chankseliani et al., 2021; Price et al, 2021). It provides a multitude of benefits and opportunities that profoundly impact both individual lives and society as a whole. Specifically, it offers a platform for in-depth learning and specialised knowledge across various fields, preparing individuals with the skills, expertise, and intellectual capabilities essential for excelling in their chosen professions. This results in numerous positive outcomes and chances for adapting to complex work environments and meeting industry demands (Baum, and Payea, 2005; Hill et al.,2005; Jongbloed et al., 2008). At the same time, it serves as a prerequisite for accessing higher-paying jobs. In today's competitive job market, employers actively seek candidates with higher educational qualifications. By obtaining a degree or certification in a specific discipline, individuals enhance their employability and gain a competitive advantage over others (Ali and Jalal, 2018). Conceptually, individuals with higher education qualifications have better chances of obtaining employment and earning higher wages compared to those with lower levels of education (Ionescu and Cuza,2012; Ali and Jalal, 2018).

As well, higher education is a substance for socio-economic mobility (Nazimuddin, 2015; Marginson, 2018). It enables individuals from diverse backgrounds to break free from the existing rigidities and achieve upward economic mobility which in turn, contributes to reducing income inequalities and fostering social inclusion. Furthermore, higher education functions as a pathway for individuals from disadvantaged backgrounds to achieve upward economic mobility. More clearly, it plays a substantial role in advancing the social and economic well-being of individuals belonging to marginalized communities[1] (Edwards, and Coates, 2011; Marginson, 2018). Higher education fosters personal growth by stimulating intellectual

[1] Marginalized communities refer to a group of people who are systematically disadvantaged and excluded from various opportunities and resources due to multiple factors such as caste, religion, gender, socioeconomic status, and disability.

curiosity, creativity, and improving communication skills. Specifically, it underscores the elevation of personal values, ethics, and societal responsibility, resulting in the well-rounded growth of individuals and equips them to make well-informed decisions and offer positive contributions to society (Boni and Walker, 2016; Chankseliani et al., 2021). Thus, higher education has been given a special place in the development model (Owens, 2017; Heleta, and Bagus, 2021; Chankseliani and McCowan, 2021). The National Education Policy (NEP) 2020 emphasises the pivotal role of higher education institutions in developing holistically educated, skilled and globally competent citizens.

## 1.2. Status of Higher Education in India

Since India's independence, the higher education sector has experienced significant expansion. At the time of independence, there were only 20 universities and 500 colleges in the country, accommodating 2.1 lakh students in the higher education system. These figures gradually increased, with 2.6 lakh students enrolled across all disciplines in higher education during the academic year 1950-51, distributed among 750 colleges and 30 universities. Subsequently, there has been substantial growth, reaching approximately 2.7 crore students, spread among 33 thousand colleges, 621 universities and 11095 stand-alone institutions in the year 2010-11[2]. The enrolment statistics pertaining to universities, colleges, and standalone institutions in the higher education system, based on the All India Survey on Higher Education (AISHE) reports from 2011 to 2022[3] has been discussed in Table 1.1.

The higher education system in India has shown substantial growth in the number of institutions and enrolments. During the period of (2017–2022), the number of institutions of higher education (including all disciplines) in India has increased at a rate of 17.37%. As of 2021-22, there were 1,168 universities, 45,473 colleges, and 12,002 stand-alone registered institutions. Here, the number of universities has increased from 903 in 2017-18 to 1,168 in 2021-22, signifying a notable rise of 265 universities. Since the year 2012-13 (667 universities), a total of 501 new universities have been registered over the span of ten years, including 55 new additions in 2021-22. Similarly, the number of registered colleges has grown to 45,473 in 2021-22 from 39,050 in 2017-18, indicating an increase of 6,423 colleges, or an increase of 16.45%.

[2] Higher Education in India at a Glance, UGC, February 2012.
[3] AISHE reports provide comprehensive data on various aspects of higher education in India, including number of institutions, enrolment statistics and Gross Enrolment Ratio (GER). The reports are published annually by the Ministry of Education, Government of India, https://aishe.gov.in/aishe/viewDocument.action?documentId=353.

However, the number of new colleges has increased by 9,948 within ten years (from 2012-13 to 2021-22), reflecting an increase of 28%, with 1,677 new colleges being registered in 2021-22. Also, the higher education system witnessed an increase of 1,991 standalone institutions over the 5-year period from 2017-18 (with 10,011 standalone institutions) to 2021-22 (with 12,002 standalone institutions), representing a growth rate of 19.89%.

**Table-1.1: Overview of Higher Education Institutions and Enrolment in India**

| Year | Total number of Higher Education Institutions | | | | Total Students Enrolment | Gross Enrolment Ratio (GER) |
|---|---|---|---|---|---|---|
| | Universities | Colleges | Stand-alone Institutions | Grand Total | | |
| **2010-11** | 621 | 32974 | 11095 | 44690 | 2,74,99,749 | 19.4 |
| **2011-12** | 642 | 34852 | 11126 | 46620 | 2,91,84,331 | 20.8 |
| **2012-13** | 667 | 35525 | 11565 | 47757 | 3,01,52,417 | 21.5 |
| **2013-14** | 723 | 36634 | 11664 | 49021 | 3,23,36,234 | 23 |
| **2014-15** | 760 | 38498 | 12276 | 51534 | 342,11,637 | 24.3 |
| **2015-16** | 799 | 39071 | 11923 | 51793 | 3,45,84,781 | 24.5 |
| **2016-17** | 864 | 40026 | 11669 | 52559 | 3,57,05,905 | 25.2 |
| **2017-18** | 903 | 39050 | 10011 | 49964 | 3,66,42,378 | 25.8 |
| **2018-19** | 993 | 39931 | 10725 | 51649 | 3,73,99,388 | 26.3 |
| **2019-20** | 1043 | 42343 | 11779 | 55165 | 3,85,36,359 | 27.1 |
| **2020-21** | 1113 | 43796 | 11296 | 56205 | 4,13,80,713 | 27.3 |
| **2021-22** | 1168 | 45473 | 12002 | 58643 | 4,32,68,181 | 28.4 |

Source: AISHE Annual Reports, 2010-11 to 2021-22

Next, the estimated total enrolment in 2021-22 was 4,32,68,181 consisting of 96,38,345 in universities, 3,14,59,092 in colleges, and 21,70,744 in stand-alone registered institutions. In just one year of the post-Covid period, total enrolment increased from 4,13,80,713 in 2020-21 to 4,32,68,181 in 2021-22, showing an increase of 4.6%. Considering the growth over the last five years (2017-18 to 2021-22), enrolment increased from 3,66,42,378 students to 4,32,68,181, presenting an overall growth of 18.1%. The increase in enrolment from 2014-15 to 2021-22 is notable, with an increase of approximately 91 lakhs, the enrolment was 3,42,11,637 in 2014-15. The Gross Enrolment Ratio (GER) in higher education[4] at the all-India level has

[4] Gross enrolment ratio (GER) in higher education is the ratio of students enrolled in post higher secondary classes to total population in 18-23 age group.

experienced an upward trend throughout the period under review. The GER reached 28.4 in 2021-22 as compared to 27.3 in 2020-21, 25.8 in 2017-18 and 21.5 in 2012-13, showing a progress during the year. In 2010-11 and 2011-12, the GER was recorded at 19.4 and 20.8 respectively.

If the total students enrolled in higher education (4.33 crore) are classified level wise, out of them, 3.41 crore students (78.91% of total enrolment) are enrolled at the undergraduate level, followed by 52.18 lakh (12.06% of total enrolment) at the postgraduate level. The remaining 39.82 lakh (9.03% of total enrolment) are enrolled in other levels of higher education[5] (AISHE Annual Report, 2021-22). Focusing on the enrolment numbers at the Undergraduate level (3.41 crore) in higher education, 62.3% of students belong to three major disciplines (Arts, Science, and Commerce). The highest enrolment is in Arts (34.2%), followed by Science (14.8%), and Commerce (13.3%). The remaining 37.7% of undergraduate students are pursuing professional courses such as engineering and technology, education, medicine, agriculture, management, law, and others. Within the professional courses (37.7%), engineering and technology constitute a significant share, accounting for 14.6% of the overall enrolment in 2021–2022, including 2.8% share of IT & Computer fields (AISHE Annual report, 2021-22).

With these figures, India has grown into one of the largest systems of higher education globally. Out of higher education as a whole, engineering education has always remained a preferred stream among students. However, its demand aggravated after liberalization and globalization in 1990–91 (Arun-Kumar, 2008; Singh, 2014). The engineering education has experienced a phenomenal growth since 1990-91, and has contributed significantly to the overall landscape of higher education.

## 1.3. Status of Engineering Education in India

Engineering education significantly contributes to a country's overall economic development. It plays a crucial role in technological advancements, fostering innovation, and overall skill development and produces "specialised human capital" which donates to dynamic economic growth, generating direct financial benefits and playing a similarly significant role in creating a huge number of social externalities. Determinately, it helps to the national development in

[5] Other levels of higher education include programs such as Ph.D., M.Phil., Diploma, PG-diploma, Certificate, and Integrated Programs.

producing skilled human resources (Sahoo and Das, 2019; Unterhalter, and Howell, 2021; Tilak and Choudhury, 2021). In fact, the rising demand for engineering education is determined by its perceived advantages over general education[6] (Alpay, 2013; Tilak, 2021). Recognised for its vital role in technological progress and national development, engineering disciplines merge scientific principles with practical research to generate new knowledge and drive systemic change. In conclusion, Indian policymakers and planners have recognized its importance, leading to a deliberate and continuous growth of higher education, particularly in the field of engineering (Chowdhury and Alam, 2012; Choudhury, 2016; Tilak, 2020; Bing, 2023).

The significant growth in engineering education has been observed in India following globalisation during the last decade of the previous century (Singh and Singh, 2018). In subsequent years, the number of institutions offering engineering education in India increased by thirteen percent, while institutions in higher education, encompassing all disciplines, grew by only five percent (Selected Educational Statistics, 2005-06 to 2010-11). However, the expansion of engineering education can be attributed to the increased involvement of the private sector in offering engineering programs compared to other disciplines in higher education (Banerjee and Muley, 2007; Tilak and Choudhury, 2021), as supported by the data presented in Table 1.2.

Table- 1.2 presents an overview of engineering institutions and total intake of students at various levels (Diploma, UG, and PG level) of engineering education in India from the academic year 2012-13 to 2022-23. It discusses institutions by their management i.e. government and private, showing that the availability of private institutions is higher than that of government institutions during this period (2012 to 2023). According to the data presented, in the year 2012-13, there were 1,233 government and 4,857 private engineering institutions, totalling 6,090 institutions with a total intake of 2,695,243 students. Over the years, the number of institutions, both government and private, increased steadily until 2015-16. After that, a gradual decline was seen in private institutions, but growth in government institutions continued till 2022-23. The continued growth of government institutions can be attributed to

[6] General education typically refers to a broad-based education that covers a wide range of subjects, which aims to provide students with diverse skills and knowledge, as well as prepare students for further education. While it may not provide the same perceived benefits and employability-related qualifications as engineering education.

strategic investments, policies and initiatives aimed at increasing access to quality engineering education across the country.

**Table -1.2: Engineering Institutions (Management-wise) in India**

| Year | Total number of Institutions | | | Total Intake | | | |
|---|---|---|---|---|---|---|---|
| | Govt. | Private | Grand Total | Diploma | UG Level | PG Level | Grand Total |
| **2012-13** | 1233 | 4857 | 6090 | 1008347 | 1548654 | 138242 | 2695243 |
| **2013-14** | 1309 | 4910 | 6219 | 1136289 | 1634408 | 181583 | 2952280 |
| **2014-15** | 1379 | 5007 | 6386 | 1262028 | 1705437 | 215550 | 3183015 |
| **2015-16** | 1467 | 4964 | 6431 | 1255749 | 1631420 | 207397 | 3094566 |
| **2016-17** | 1599 | 4875 | 6474 | 1244862 | 1557470 | 197202 | 2999534 |
| **2017-18** | 1681 | 4764 | 6445 | 1208518 | 1476128 | 186042 | 2870688 |
| **2018-19** | 1747 | 4528 | 6275 | 1125034 | 1404640 | 182204 | 2711878 |
| **2019-20** | 1826 | 4340 | 6166 | 1043513 | 1329339 | 168660 | 2541512 |
| **2020-21** | 1858 | 4197 | 6055 | 1008244 | 1286725 | 147669 | 2442638 |
| **2021-22** | 1896 | 4032 | 5928 | 976955 | 1253337 | 136978 | 2367270 |
| **2022-23** | 1928 | 3932 | 5860 | 969072 | 1270482 | 130277 | 2369831 |

Sources: AICTE Annual reports, from 2012-13 to 2022-23

However, there is a visible pattern of growth in the total number of institutions from 2012-13 to 2017-18, followed by a slow decline in subsequent years. In the last academic year (2022-23), private institutions reached around 3932 (67.1% of total), followed by government institutions with 1928 (32.9% of total). It still supports clarity on greater involvement of the private sector in engineering education, which has surpassed the government sector. Amidst this trend, engineering education significantly contributes to the overall landscape of higher education, producing skilled professionals, and addressing societal challenges crucial for national development.

Also, the total intake of students showed a similar trend, reaching its peak in 2014-15 and gradually decreasing thereafter with the declining rate of institutions. During the period from 2012 to 2023, the total intake capacity of engineering students including all levels[7] is more than

[7] All levels: This includes undergraduate, postgraduate and diploma programs in engineering education.

2 lakhs in each academic year, and in maximum years, it is close to 3 lakhs. The total intake capacity of engineering institutions accounted for approximately 2,369,831 in the year 2022-2023, with the highest intake capacity is at UG level 1270482 (53.61 per cent to total), followed by diploma level 969072 (40.89 per cent to total), and only 130277 at PG level (5.5 per cent). The data indicates that the UG level of engineering education consistently demonstrates the highest intake capacity compared to diploma and PG levels each year. Discussion over the periods reveals fluctuations and trends in the establishment of engineering institutions and intake capacity of the institutions, these trends underscore the dynamic nature of engineering education in India.

Moreover, engineering education in India has witnessed tremendous enrolment growth and has become an important pillar of the country's education system (Bhattacharya, 2008; Subramanian, 2015; Choudhury, 2016). In fact, increase in enrolment not only reflects the growing demand for engineering skills, but also emphasizes the significant input of this sector to the educational and technological progress of the country. Especially, the demand for engineering courses has increased due to the increasing importance of industrial development in various sectors including manufacturing, infrastructure, agriculture, and information technology. With the rapid advancement of technology and the increasing demand for skilled engineers, engineering programs have become highly sought after by students aspiring to pursue careers in various industries (Bhardwaj and Kumar, 2022; López-Pérez et al., 2023; Wint, 2023). This flow in demand has created a competitive environment for admission to engineering programs, where students struggle for limited seats in prestigious institutions. In India, where engineering has emerged as a popular discipline, ensuring equitable access to engineering education has become a matter of paramount importance (Loyalka *et al.*, 2014; Swarup and Dey, 2020).

The growth of engineering education in India over the past few decades has outpaced the expansion seen in overall higher education. According to the University Grants Commission (UGC) Annual Reports for 1990-91 and 2010-11, enrolment in engineering education surged by seven times during this period, compared to a threefold increase in overall higher education across all disciplines. This growth trajectory underlines the importance of engineering as a preferred field of study among students. In this context, Table-1.3 provides an overview of enrolment trends in engineering education by gender for the academic years spanning from 2012-13 to 2022-23.

**Table-1.3: Enrollment in Engineering Education in India**

| Total Students Enrolment | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Year | Diploma | | UG Level | | PG Level | | Grand Total | | |
| | Male | Female | Male | Female | Male | Female | Male | Female | Total |
| **2012-13** | 483834 (70.81) | 199482 (29.19) | 645913 (66.85) | 320284 (33.15) | 58938 (58.07) | 42560 (41.93) | 1188685 (67.89) | 562326 (32.11) | 1751011 |
| **2013-14** | 615850 (84.48) | 113142 (15.52) | 684342 (72.46) | 260050 (27.54) | 74770 (58.99) | 51979 (41.01) | 1374962 (76.38) | 425171 (23.62) | 1800133 |
| **2014-15** | 629418 (84.86) | 112286 (15.14) | 635058 (72.56) | 240179 (27.44) | 72648 (59.23) | 50014 (40.77) | 1337124 (76.86) | 402479 (23.14) | 1739603 |
| **2015-16** | 616289 (84.03) | 117131 (15.97) | 616665 (72.12) | 238347 (27.88) | 53138 (58.84) | 37167 (41.16) | 1286092 (76.61) | 392645 (23.39) | 1678737 |
| **2016-17** | 591306 (83.79) | 114368 (16.21) | 557797 (70.97) | 228165 (29.03 | 41792 (60.22) | 27607 (39.78) | 1190895 (76.29) | 370140 (23.71) | 1561035 |
| **2017-18** | 557906 (83.55) | 109882 (16.45) | 530573 (70.71) | 219774 (29.29) | 41828 (60.91) | 26847 (39.09) | 1130307 (76.02) | 356503 (23.98) | 1486810 |
| **2018-19** | 522923 (83.3) | 104805 (16.7) | 509643 (70.59) | 212320 (29.41) | 40575 (60.85) | 26104 (39.15) | 1073141 (75.77) | 343229 (24.23) | 1416370 |
| **2019-20** | 504140 (82.89) | 104094 (17.11) | 524016 (70.7) | 217171 (29.3) | 39809 (63.28) | 23097 (36.72) | 1067965 (75.62) | 344362 (24.38) | 1412327 |
| **2020-21** | 418506 (82.09) | 91280 (17.91) | 500074 (70.09) | 213408 (29.91) | 39233 (63.74) | 22314 (36.26) | 957813 (74.55) | 327002 (25.45) | 1284815 |
| **2021-22** | 375609 (82.47) | 79829 (17.53) | 500088 (68.36) | 231435 (31.64) | 30312 (64.07) | 16998 (35.93) | 906009 (73.4) | 328262 (26.6) | 1234271 |
| **2022-23** | 465742 (80.7) | 111368 (19.3) | 583113 (66.4) | 295069 (33.6) | 28905 (65.35) | 15325 (34.65) | 1077760 (71.87) | 421762 (28.13) | 1499522 |

Sources: AICTE Annual reports, from 2012-13 to 2022-23

In the academic year 2012-13, the total enrolment was 1,751,011, with 1,188,685 male students (67.89%) and 562,326 female students (32.11%). The highest total enrolment is observed in the academic year 2013-14, reaching 1,800,133 with 1374962 male students (76.38%) and 425171 female students (23.62%). In subsequent years, total enrolment has declined steadily, with fluctuations in gender distribution. After a continuous decline in enrolment for some years, there was a slight increase observed in total enrolment in the academic year 2022-23, with 1,077,760 male students (71.87%) and 421,762 female students (28.13%), bringing the total enrolment to 1,499,522. In terms of gender distribution, the overall percentage of male students has always been higher than that of female students in engineering education. Over the period

from 2012 to 2023, the total share of female participation in engineering was highest in the year 2012-13 (32.11%). The following years exhibited a decline in the percentage of female in engineering. However, in recent years again the percentage of female students has been gradually increasing, indicating a positive trend towards gender parity in engineering education enrolment.

Similarly, it shows the share of male and female in enrolment at Diploma, Undergraduate (UG), and Post Graduate (PG) levels of engineering education separately for the academic years 2012-13 to 2022-23 (Table-1.3). The enrolment at different levels of engineering programs shows a fluctuating trend over the years. In the Diploma level the highest enrolment recorded in 2014-15 (741,704 students) and the lowest enrolment in 2021-22 (455438 students). The enrolment in diploma level exhibits a declining trend from 2015-16 to 2022-23, indicating potential shifts in student preferences.

The UG level enrolment also displays a similar fluctuating trend, with the highest enrolment recorded in 2012-13 (966,197 students) and the lowest in 2020-21 (713482 students). However, the enrolment in UG program shows a slight increase over the years, with variations in the gender distribution. Despite fluctuations, UG level enrolment generally remains higher compared to diploma and PG levels, reflecting the popularity of undergraduate engineering programs among students.

Enrolment in the PG program shows relatively lower numbers compared to other levels, with the highest enrolment recorded in 2013-14 (126,749 students) and the lowest in 2022-23 (44,230 students). The enrolment in this program has shown a continuous declining trend since the year 2014-15, possibly indicating a decrease in the number of students opting for postgraduate studies in engineering or shortages in the availability of PG programs.

Overall, the data reveals that among these three levels of engineering education in India, the undergraduate level has the highest enrolment numbers. The data also highlights the gender dynamics in enrolment across different levels of engineering education, with a consistent pattern of higher enrolment of male students compared to female students. There is a persistent and high disparity in gender representation in diploma level engineering programmes, with significantly lower enrolment of females compared to males throughout the years. Although, the gender gap is narrower in PG programs compared to diploma and UG levels. Likewise,

enrolment of males in UG programs is higher than that of females, while also noting that the enrolment percentage of female students is gradually increasing over time. It reflecting efforts towards gender inclusivity in higher education, and provides insights into the trends and patterns of enrolment in engineering education institutions in India, highlighting the gender dynamics over the years.

## 1.4. Engineering Education in Delhi

Focusing on the current state of engineering education in India, marked by the presence of approximately 6000 engineering institutions and a consistent increase in government institutions, underscores the prominence of the undergraduate (UG) level in terms of both intake capacity and enrolment. Shifting attention to the specific context of engineering education at the UG level in Delhi, it's observed that the sector has also experienced significant growth. Prior to the turn of the century, Delhi housed only two UG-level engineering institutes, enrolling a total of 3908 students in 1990-91. Subsequently, a gradual increase was noted, with three institutions and 3947 enrolments recorded in 1995-96. By 2000-01, the number of engineering institutions had surged to nine, enrolling 4923 students at the UG level, as reported by AICTE data from 1990 to 2000.

**Table-1.4: Enrolment, Passed students, and Placement status of Engineering Institutions in Delhi**

| Year | Institutions | | | Intake | Enrolment | | | Stu. passed | Place-ment |
|---|---|---|---|---|---|---|---|---|---|
| | Govt. | Pvt. | Total | | Male | Female | Total | | |
| **2012-13** | 12 | 8 | 20 | 7532 | 6100 (84.11) | 1152 (15.89) | 7252 | 5041 (69.51) | 2482 (34.26) |
| **2013-14** | 12 | 8 | 20 | 9007 | 6033 (84.78) | 1083 (15.22) | 7116 | 5321 (74.78) | 3019 (42.43) |
| **2014-15** | 10 | 8 | 18 | 8965 | 6535 (83.84) | 1260 (16.16) | 7795 | 5995 (76.91) | 4152 (53.26) |
| **2015-16** | 13 | 7 | 20 | 9265 | 6884 (79.12) | 1817 (20.88) | 8701 | 7578 (87.09) | 4942 (57) |
| **2016-17** | 11 | 7 | 18 | 8455 | 6910 (85.38) | 1183 (14.62) | 8093 | 6253 (77.26) | 3532 (43.64) |
| **2017-18** | 11 | 9 | 20 | 9195 | 6576 (84.33) | 1222 (15.67) | 7798 | 6560 (84.12) | 3411 (43.74) |
| **2018-19** | 11 | 8 | 19 | 9098 | 5906 (84.71) | 1066 (15.29) | 6972 | 6069 (87.04) | 4201 (60.26) |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **2019-20** | 12 | 7 | 19 | 9698 | 6490 (85.11) | 1135 (14.89) | 7625 | 5910 (77.51) | 5498 (72.1) |
| **2020-21** | 12 | 7 | 19 | 10209 | 5631 (77.3) | 1654 (22.7) | 7285 | 6631 (91.02) | 5006 (68.72) |
| **2021-22** | 11 | 8 | 19 | 11361 | 6947 (78.93) | 1855 (21.07) | 8802 | 5873 (66.72) | 5795 (65.84) |
| **2022-23** | 14 | 9 | 23 | 12384 | 8358 (78.67) | 2266 (21.33) | 10624 | 7480 (70.41) | 6426 (60.49) |

Sources: AICTE Annual reports, from 2012-13 to 2022-23

Table-1.4 presents an inclusive insight into UG level engineering education in Delhi, encompassing data from 2012-13 to 2022-23. It reveals a gradual increase in institutions and enrolment figures, with 20 degree-level engineering institutions enrolling 7,252 students in 2012-13. Despite the constant number of institutions, the enrolment growth trend continued, reaching approximately 7,798 students by 2017-18. Subsequently, both enrolment and institution count saw noticeable growth, with 23 institutions enrolling 10,624 students in 2022-23. These figures effectively highlight the notable expansion in the engineering education sector in Delhi during the specified period, with the higher number of government-owned institutions and the lesser number of private institutions. According to the AICTE report of 2022-23, the data reveals a higher number of degree-level engineering institutions and higher intakes and enrolments compared to other levels of engineering education like diploma and PG programs. Moreover, the expansion rate of engineering education in Delhi has exhibited remarkable growth, surpassing the growth rate of other disciplines in higher education. Despite the expansion of institutions, the level of participation in engineering education remains comparatively lower when compared to other disciplines in higher education (Choudhury, 2016; Valero, 2022).

Furthermore, it presents a notable gender gap, with consistently higher male enrolments compared to female enrolments throughout the years. Enrolment numbers fluctuate over the years, indicating variations in demand for engineering education. The data shows not all enrolled students are able to successfully complete their education and secure employment opportunities. While increased enrolment may provide opportunities for more students to pursue engineering education, it does not guarantee higher academic success or job placement rates. In recent years, such as 2021-22 and 2022-23, the total enrolment numbers (8802 and 10624) are relatively high, but the passed student numbers (5873 and 7480) are very lower compared to enrolment, suggesting challenges in student retention or academic performance.

In contrast, in the year 2020-21, the passing student numbers (6631) are close to the enrolment numbers (7285), indicating successful academic outcomes for students. The placement numbers are relatively lower than enrolment numbers over the years, it may indicate challenges in the job market, such as a lack of demand for engineering graduates or mismatches between graduates' skills and employers' requirements. However, the placement picture in 2019-20 was slightly better than other years, it was 72.1%. Overall, presenting data on enrolment, passed students and placements helps in evaluating the effectiveness of engineering education programs.

After an intensive discussion on higher education, especially on engineering education, the inclusive idea emerged that it plays an important role for the all-round development of an individual as well as a group of individuals. Education and training are instrumental in empowering people of any groups, equipping them with essential knowledge, skills, and capabilities to improve their lives, pursue opportunities, and contribute to societal advancement. It gives a chance to live a decent and respectable life within the society and beneficial in finding work and earning money to support lifestyle (Khan, 2020; Terziev, 2022; Boyadjieva, and Ilieva-Trichkova, 2023). In particular, engineering and technical education develops human resources with required skills and yields better employment and higher income to human beings, which ultimately leads to inclusive growth and development of the country (Bhargava,2001; Tilak and Choudhury, 2021). However, the country will be able to progress comprehensively when all sections of the society have the equal opportunity to participate in higher and technical education, are educationally empowered to efficiently take part in the development process and enabled to share the fruits of growth and prosperity (NEP, 2020).

It is important to discuss the participation of marginalised groups in higher education, especially in engineering, as they are underrepresented in this field, highlighting the slow progress in their inclusion. These groups face various formidable barriers to participation, as they are socially and economically backward compared to more privileged groups in the society (Iqbal, 2012; Silbey,2016; Sabharwal & Malish,2018; Swarup and Dey, 2020; Patterson et al., 2021). Where participation in higher education can improve the lifestyle of these groups, as it has a direct impact on the socio-cultural progress of the society as well as employment and earnings. It also contributes to broader economic expansion, income distribution, and active participation in development initiatives. Thus, higher education is considered as the prime

engine of upward progress of marginalized groups, offering pathways to reduce socio-economic inequalities within society (Morley, 2006; Joshi, 2010; Joshi and Ahir, 2019).

Unfortunately, the education system in India is grappling with the challenge of ensuring equal opportunities for all students, particularly in terms of access to higher education, which remains inequitable for those from marginalised backgrounds. Historically, certain groups in India, such as socially backward castes (SC, ST, and OBC), religious minorities, and women may be considered marginalised groups (Bordoloi, 2012; Joshi, 2015; Sankaran, et al., 2017; Brahmanandam, 2023; Khatoon, 2022). Religious minorities in India also face discrimination in higher education, with limited access to participation, with the Muslim community being one of the most marginalised groups here (Fortenberry, 1994; Huang,2000; Ali and Bagheri, 2009; Kargarmoakhar and Ross, 2019). To address these disparities, the Government of India has implemented various affirmative actions in higher education including engineering education, to ensure equal educational opportunities and to promote diversity within academic institutions.

## 1.5. Socially Backward Castes and Minorities in India

Socially Backward Castes refer to communities that have been historically disadvantaged and marginalized in Indian society. Minorities in India comprise religious groups with smaller population shares, often facing discrimination and socio-economic challenges. The details about socially backward castes and minority groups in India are discussed separately below:

### 1.5.1. Socially Backward Castes in India:

In India, students from majority groups i.e., Hindu belong to different castes or communities, with the caste system classified into four groups: General, Scheduled Castes (SC), Scheduled Tribes (ST), and Other Backward Classes (OBC). Among these, socially backward castes refer to certain castes or communities that historically faced social and economic disadvantages, often due to factors like discrimination, marginalisation, and lack of access to resources and opportunities. These communities are identified as backward based on criteria such as educational and economic status, social hierarchy, and historical disadvantage, which may have led to lower educational or economic status. As per the constitution of India, socially backward

castes include Scheduled Castes (SC), Scheduled Tribes (ST), and Other Backward Classes (OBC).

Scheduled Castes, also known as Dalits, have traditionally been at the lowest stage of the social hierarchy, facing discrimination and exclusion. Scheduled Tribes comprise indigenous or tribal communities that have historically faced marginalisation and lack of access to resources. Other Backward Classes encompass a diverse range of communities that have faced social, economic and educational backwardness but do not fall under the categories of SC or ST. Students from these three castes generally exhibit low socio-economic indicators, which hinder their full participation in education and societal integration. In fact, they encounter comparatively greater socio-economic and educational challenges compared to students from the general category (Shah, 1991).

More precisely, belonging to socially backward castes means being a member of these communities (SC, ST and OBC) that have been historically deprived and marginalized in the society. As per the constitution in India, individuals from these communities are eligible for specific benefits and privileges (Biswas, 2018; Kumar et al., 2020), which may be implemented through governments at both the central and state levels affirmative action policies, including reservations in education and employment, to uplift these communities and address social inequalities.

### 1.5.2. Minorities in India:

India is a secular country and gives everyone a chance to follow the religion of their choice. There are seven major religions in India as follows: Hindu, Muslim, Sikh, Buddhist, Christian, Jain and Parsi. As per the Section 2 (c) of the National Commission for Minorities Act, 1992; Muslims, Sikhs, Christians, Buddhists, Jains and Parsis have been notified as minorities in India, and their population in the country makes up smaller, constituting around 20% of the total population with the rest being Hindus. Among the minorities, Muslims are the largest group with 14.2%, followed by Christians 2.3%; Sikhs 1.7%, Buddhists 0.7%, Jains 0.4% and Parsis 0.006%. Muslims constitute around more than 20% of the population in some states, including Jammu Kashmir, Bengal, and Assam (GOI, 2011).

Thus, in the Indian context, minorities refer to religious groups with smaller population shares compared to the majority community (Hindu). The minority status is granted based on criteria

outlined in the above-mentioned act, acknowledging their distinct identity and the need for safeguarding their rights and interests within the diverse peoples of Indian society. Despite India being a secular country that upholds religious freedom, religious minorities often face various socio-economic challenges and discrimination, which can hinder their educational advancement. Hence, it is important to ensure equal access to education, including engineering education, for religious minorities to foster inclusivity, promote diversity and facilitate their overall development (Terziev, 2022). However, religious minorities have the right to establish and manage educational institutions according to their requirements, and other affirmative programs are also provided to promote diversity, equity, and inclusion within these communities.

## 1.6. Affirmative Actions in Engineering Education

In the pursuit of a just and equitable society, various affirmative actions have been taken by the higher education system in India. Affirmative action in higher education, including engineering refers to policies and practices designed to increase the representation of historically marginalized groups, who have faced discrimination in colleges and universities, as well as groups that are underrepresented based on other factors[8]. These policies may include reservation policies in enrolment, provisions to establish educational institutions, preferential admissions criteria, specific enrolment efforts, and other support services, aimed at promoting equal access to education and social justice. The overarching objective of affirmative action in higher education is to address past and present discrimination, promote educational access for underrepresented groups, and create more inclusive learning environments. Affirmative action policies in engineering education typically applies to various groups, particularly those who are underrepresented and face discrimination. Some of these selective groups are listed below:

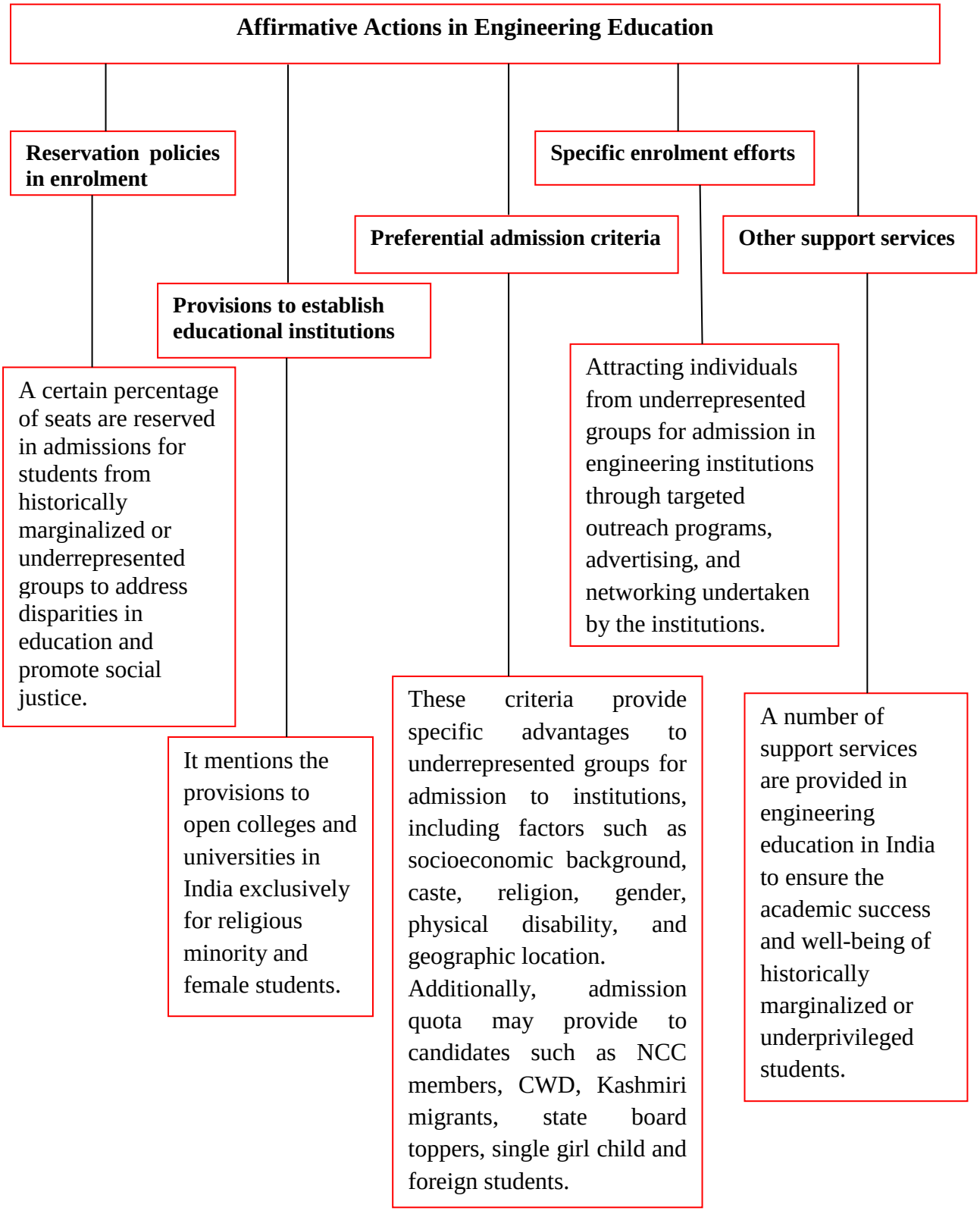
1. Castes: Scheduled Castes (SC), Scheduled Tribes (ST), and Other Backward Classes (OBC) are marginalized groups in India, facing social, economic, and educational disadvantages compared to privileged castes like the General category.

[8] Other factors: It refers to any other conditions beyond historical marginalization and discrimination that result in under-representation in higher education, such as economic status, geographic location, and educational background.

2. Religion: Religious minority groups also facing discrimination in engineering education, especially, Muslims often face more social and educational disadvantages and are included among marginalized groups.
3. Gender: Women especially in the engineering field, traditionally dominated by men.
4. Economically weaker sections (EWS): Individuals from economically disadvantaged backgrounds or marginalized groups who face discrimination in the engineering field
5. Disability: Individuals with disabilities who may face barriers to education.

Government of India has implemented various measures and programmes to promote participation in the engineering education sector, ensuring access and opportunities for marginalized communities. The dominant view states that the groups such as SCs, STs, OBCs, religious minorities, women, EWS and persons with disabilities can benefit from affirmative action policies in higher education, including engineering. The policies aim to enhance their access to engineering education opportunities and mitigate disparities in educational outcomes for these groups. Here is an outline of the types of affirmative action in engineering education in India:

**Figure-1: Affirmative Action in Engineering Education in India**



The study comprehensively elucidates reservation policies in enrolment, and other affirmative actions in engineering education. It separately discusses caste, religion, gender, and others, along with relevant articles and acts, which are given below:

### 1.6.1. Reservation Policies in Enrolment

It refers to an affirmative action measures implemented by governments to allocate a certain percentage of seats in educational institutions for students from historically marginalized or underrepresented groups, known as admission quotas. Various reservation policies are designed to address inequalities and promote social justice by providing educational opportunities to these groups, who already face discrimination or disadvantage based on factors such as castes, economic status and Persons with Disabilities (PWD). Reservation policies may vary depending on the state and context, but they typically aim to ensure proportional representation and increase access to opportunities for these marginalized communities.

#### 1.6.1.1. Reservation in Enrolment for Scheduled Castes (SC) and Scheduled Tribes (ST):

The government provides reservations for SCs and STs in educational institutions, such as admission quotas. Admission quotas are primarily based on certain caste groups and applies to 7.5% of seats for Scheduled Tribes (ST) and 15% of seats for Scheduled Castes (SC) in higher education institutions, who are socially and economically backward from more privileged groups. It has evolved over the years to include historically marginalized groups such as SCs and STs in the education system. The policy aims to increase representation and provide opportunities to these groups in education, and create a more inclusive society. However, this reservation can help students from these communities by securing seats in educational institutions, promote their educational advancement and overcome historical disadvantages. Reservations for Scheduled Castes (SCs) and Scheduled Tribes (STs) in educational institutions in India are primarily provided under two key articles of the Indian Constitution:

1. Article 15(4): This article enables the state to make special provisions for the advancement of socially and educationally backward castes such as SCs and STs. It

allows for the reservation of seats in admission to educational institutions for these categories to ensure their representation and access to educational opportunities.

2. Article 46: This article directs the state to promote the educational and economic interests of SCs and STs and protect them from social injustice and all forms of exploitation. It emphasizes the need for the state to provide special care and attention to the educational needs of these communities.

The percentage of reservation for SCs and STs in educational institutions varies across states and institutions. The percentage is typically determined by the respective state governments or educational authorities, considering factors such as the population of SCs and STs in the state, historical disadvantages, and social realities. As an example, let's consider the reservation percentages in central educational institutions, which are applicable nationwide. The University Grants Commission (UGC) provides guidelines for reservation in central universities. Indian Institutes of Technology (IITs) and National Institutes of Technology (NITs) follow the reservation policy set by the Ministry of Human Resource Development (MHRD). As per these guidelines, the reservation percentage for SCs is 15% and for STs is 7.5% in admissions to undergraduate and postgraduate courses in engineering institutions. It's important to note that the reservation percentages mentioned here are only illustrative and can vary based on specific state government policies, central government guidelines, and institutional practices. The actual percentages may differ across different states and educational institutions, as per the reservation policies implemented by the respective authorities. These reservation provisions under Article 15(4) and Article 46 aim to ensure social justice, inclusivity, and equal opportunities for SCs and STs in educational institutions, facilitating their educational advancement and overall socio-economic progress.

#### 1.6.1.2. Reservation in Enrolment for Other Backward Classes (OBC):

The government also introduces reservation for OBCs in educational institutions, it applies to 27% seats for them. This reservation aims to provide opportunities for students from socially and educationally backward communities to pursue higher education. The Mandal Commission report in 1990 played a significant role in recommending and implementing OBC reservation. Also, reservations for Other Backward Classes (OBCs) in educational institutions in India are primarily provided under two key articles of the Indian Constitution:

1. Article 15(5): This article allows the state to make special provisions for the advancement of socially and educationally backward classes of citizens, which includes OBCs. This article primarily focuses on reservations in admission and other affirmative action in educational institutions, aimed at addressing social and educational disparities. It also enables the reservation of seats for OBCs, to ensure their representation and access to educational opportunities.
2. Article 16(5): This article of the Indian Constitution allows the state to make provisions for the reservation of appointments or posts in favour of any backward class of citizens, which in the context of education, includes Scheduled Castes (SCs), Scheduled Tribes (STs), and Other Backward Classes (OBCs). While this article primarily addresses reservations in public employment, its principles have been extended to educational admissions through various legislations and policies, ensuring representation and access to educational opportunities for these marginalized communities.

The percentage of reservation for OBCs in educational institutions is typically determined by the respective state governments or educational authorities, in view of the factors such as population of OBCs in the state, historical disadvantages, and social realities. As per UGC guidelines, the reservation percentage for OBCs is 27% in admissions to undergraduate and postgraduate courses in engineering institutions. The reservation policy of NITs and IITs is determined by MHRD, it reflects the above percentage for OBCs (27%) in admission to undergraduate engineering courses. The reservation provisions outlined in Article 15(5) and Article 16(5) are designed to promote social justice, inclusivity, and equal opportunities for Other Backward Classes (OBCs) in educational institutions. These provisions play a vital role in facilitating the educational advancement and overall socio-economic progress of OBC communities, ensuring their fair representation and access to educational opportunities.

#### 1.6.1.3. Reservation in Enrolment for Economically weaker sections (EWS):

In subsequent years, the government added reservation in enrolment for individuals belonging to economically weaker sections in educational institutions, providing reservation of seats for these groups. The reservation percentage for EWS students in educational institutions is typically up to 10%. The percentage may vary depending on government policies and regulations in different states. By reserving a certain percentage of seats in educational

institutions for these groups, the government intends to ensure their participation and upward mobility in higher education. However, this reservation may provide opportunities for students from economically disadvantaged backgrounds, who may not fall under any specific reserved category, to access quality education. Reservations for Economically Weaker Sections (EWS) in educational institutions in India are primarily provided through the following constitutional provisions and government policies:

1. The Constitution (103rd Amendment) Act, 2019: The Government of India through the implementation of the Constitution (One Hundred and Third Amendment) Act, 2019 introduced admission quota for EWS students in higher education. This amendment acquaints with Article 15(6) and Article 16(6) to provide reservations for EWS in both educational institutions and public employment. These articles allow the state to make special provisions for the advancement of EWS, including reservations in admissions and appointments.

2. Central Educational Institutions (Reservation in Admission) Act, 2006: The Government of India has implemented reservation policies for EWS in central educational institutions, including central universities, Indian Institutes of Technology (IITs), and National Institutes of Technology (NITs). As per the Central Educational Institutions (Reservation in Admission) Act, 2006, a 10% reservation is provided for EWS candidates in addition to existing reservations for SCs, STs, and OBCs.

The percentage of admission quota given to EWS students in engineering institutions is around 10%. However, the exact percentages may vary across different institutions based on their respective reservation policies. For instance, many institutions in India have implemented reservation policies for EWS students in enrolment. In some institutions, a 10% reservation for EWS is provided, while in others, it may be higher or lower. These provisions under Article 15(6) and Article 16(6) aim to ensure equitable access and opportunities for students from economically weaker sections in educational institutions. The reservations for EWS are intended to address the economic disparities and provide equal opportunities for educational advancement to individuals from economically disadvantaged backgrounds.

### 1.6.1.4. Reservation in Enrolment for Persons with Disabilities (PWD):

The government provides reservation in enrolment for persons with disabilities in educational institutions, known as admission quota for PWDs. In general, 5% of the seats in higher education institutions are allocated for them to ensure their access to educational opportunities and promote inclusivity. Many states in India have implemented reservation policies in enrolment for candidates with disabilities in educational institutions, but this may vary from state to state. The percentage of reservation varies based on the population of PWD in the state and the overall reservation policy framework. This reservation ensures that students with disabilities have equal access to education and can pursue their academic goals. Reservations for Persons with Disabilities (PWD) in educational institutions in India are primarily provided through the following constitutional provisions, legislation, and government policies:

1. The Rights of Persons with Disabilities Act, 2016: This legislation replaced the Persons with Disabilities (Equal Opportunities, Protection of Rights and Full Participation) Act, 1995, and provides comprehensive provisions for the protection and empowerment of persons with disabilities. Under this act, educational institutions are mandated to reserve seats for PWD and provide reasonable accommodations to facilitate their access to education.
2. The Rights of Persons with Disabilities Rules, 2017: These rules provide further details on the implementation of the Rights of Persons with Disabilities Act, 2016. They outline guidelines and procedures for the reservation of seats for PWD in educational institutions.
3. Central Educational Institutions: The Government of India has implemented reservation policies for PWD in central educational institutions, including central universities, Indian Institutes of Technology (IITs), and National Institutes of Technology (NITs). As per the guidelines, a 5% reservation is provided for PWD candidates in admissions, subject to certain eligibility criteria.
4. Article 41 mandates that the Government should ensure provisions for employment, education, and public assistance in situations of unemployment, sickness, disability, and other forms of undeserved deprivation.

The reservation percentage for PWD in engineering institutions is up to 5% as per the guidelines. The percentage can vary across different institutions based on their respective reservation policies, but it generally ranges from 3% to 5%. It may also be influenced by factors such as the type and extent of disability. These provisions under the Rights of Persons with Disabilities Act, 2016, and associated rules aim to ensure equal opportunities and inclusivity in educational institutions for persons with disabilities. The reservations for PWD are intended to address the unique challenges faced by individuals with disabilities and facilitate their educational advancement and overall socio-economic empowerment.

### 1.6.2. Provisions to Establish Educational Institutions

In addition to reservation policies in enrolment, there are also provisions in place to establish educational institutions that specifically cater to the requirements of religious minority and female students in India. These provisions recognize the importance of providing tailored educational opportunities to address the unique challenges and barriers faced by these groups. By establishing colleges and universities exclusively for religious minority and female students, the government aims to create inclusive learning environments where students from these communities can thrive academically and socially. These institutions may offer specialized programs, support services, and resources tailored to the cultural, religious, and gender-specific needs of the students. Moreover, it plays a crucial role in promoting diversity, fostering empowerment, and advancing educational attainment among religious minority and female populations in India.

#### 1.6.2.1. Provisions to establish educational institutions for Minorites

It referred to “Minority Educational provisions”, and describes the affirmative action policy outlined in Article 30 of the Indian Constitution, which grants minorities the privileges to establish and administer educational institutions according to their beliefs and requirements. This provision ensures that minority communities have the autonomy and freedom to establish educational institutions that provide to their specific cultural, linguistic, and religious needs. By providing minorities with the opportunity to establish and manage their own educational institutions, this affirmative action policy aims to promote diversity, equity, and inclusion in the higher education sector. It helps address historical injustices and ensures that students from minority communities have access to educational opportunities and can pursue higher studies, addressing their specific needs and challenges, respect their unique identities and perspectives.

This affirmative action for religious minorities in India is primarily provided by the constitutional provisions. While there is no specific article in the Indian Constitution that exclusively addresses reservation in enrolment for religious minorities in educational institutions. However, several other measures have been implemented to ensure their representation and access to educational opportunities through a combination of institutional efforts, legislative enactments and government policies. These measures include:

1. Article 30(1): This article of the Indian Constitution ensures the right of religious and linguistic minorities to establish and administer educational institutions of their choice, known as minority educational institutions. These institutions have the autonomy to set their admission policies and may give preference to students from their respective religious communities.
2. NCMEI Act, 2004: The National Commission for Minority Educational Institutions (NCMEI) Act establishes the National Commission for Minority Educational Institutions, which is responsible for protecting and safeguarding the educational rights and interests of religious minorities. The commission can address grievances and disputes related to reservations and other matters concerning minority educational institutions.
3. Government Policies: The government of India has formulated various policies to support and promote education among religious minorities. These policies may include different initiatives, scholarships, and other financial assistance specifically targeted towards minority communities. These programs aim to ensure equal opportunities and educational upliftment for religious minority students.

In many cases, minority institutions have discretion in determining their admission criteria and reservations, keeping in mind the specific needs and aspirations of their respective communities. These provisions, including Article 30(1) and the NCMEI Act, aim to safeguard the educational rights of religious minorities and ensure their representation and access to educational institutions. They contribute to the promotion of religious and cultural diversity in the educational landscape of India.

#### 1.6.2.2. Provisions to establish educational institutions for women

Similarly, the provision to establish gender-based colleges and universities in India is granted by government regulatory bodies such as the University Grants Commission (UGC), which oversees higher education. As per the UGC guidelines, many institutes have been established exclusively for female candidates. The establishment of institutes solely for female candidates constitutes a form of affirmative action known as gender-based affirmative action. This action aims to address gender disparities and promote the welfare of women by providing specialized educational opportunities. In addition, other affirmative actions for women may include preferential treatment, admission quotas, specific scholarships, and support services designed to benefit female students and increase their representation in higher education. The affirmative actions for women in higher education can vary depending on the specific context or location, but they generally aim to ensure representation and increase access to opportunities for women. Affirmative actions for women in educational institutions in India are primarily provided under the following articles of the Indian Constitution:

1. Article 15(3): This article empowers the state to make special provisions for the advancement of women and children. It allows the implementation of affirmative action measures, including reservation in admissions in educational institutions, to ensure gender equality. Under this Article, various educational institutions, particularly in the field of engineering, medicine, and law, may implement reservations or specific admission quotas for women to ensure their representation and encourage their involvement in these areas of study.

2. Article 16(2): This article primarily prohibits discrimination based on gender in matters of employment or office under the state. It enables the state to provide reservations for women in public employment. While it doesn't explicitly refer to educational institutions, its provisions for non-discrimination contribute to fostering an environment of equality and fairness, which can extend to various aspects of public life, including education.

Moreover, in recent years since 2018, separate admission quota has been introduced in enrolment for women candidates in central institutions like the Indian Institutes of Technology (IITs). The admission quota percentage is typically determined by the respective educational

authorities, such as the Ministry of Human Resource Development (MHRD), and it may vary across different IITs in various states, all while considering the importance of gender equality and representation in educational settings. However, there is no specific percentage of reservation for women in enrolment in other institutions. Some institutions often implement other measures such as allocating supernumerary seats for single girl children, providing specific relaxations in admission criteria, offering special scholarships for female candidates, etc., to encourage female participation and ensure gender diversity. The IITs also adopt many such affirmative measures to promote gender equality and increase women's interest in the engineering field. The affirmative actions for women mentioned here are illustrative and may vary from institution to institution depending on specific state policies, central government guidelines and institutional practices. These provisions under Article 15(3) and Article 16(2) aim to promote women's empowerment, and provide equal opportunities for women in educational institutions. It facilitates the participation and representation of women in various fields of education, fostering a more inclusive and diverse learning environment.

### 1.6.3. Preferential Admission Criteria

Preferential admissions criteria, within the context of affirmative action in higher education, are specific criteria or considerations used during the admissions process to provide preferential treatment or advantages to individuals from historically marginalized or underrepresented groups and candidate with other indicators. These criteria may include factors such as socioeconomic background, caste, religion, gender, physical disabilities, geographic location, management quotas, and others based on disadvantage or underrepresentation. Additionally, these criteria can also provide special advantages and admission quotas for candidates, including members of the national cadet corps (NCC), children of widows of defence personnel (CWD), Kashmiri migrants, state board toppers, single girl child, and foreign students. The aim of preferential admissions criteria is to promote diversity and equity within colleges and universities by ensuring that individuals from diverse backgrounds have fair and equal access to educational opportunities.

### 1.6.4 Specific enrolment criteria

Enrolment efforts in the context of affirmative action in higher education refer to initiatives undertaken by educational institutions to actively newcomer individuals from underrepresented

or marginalized groups. These efforts may include targeted outreach, advertising, and networking to attract a diverse pool of candidates for admission to colleges or universities. The goal is to increase the representation of socially and economically disadvantaged groups within the student body of the institution.

### 1.6.5. Support services:

Support services within the context of affirmative action in higher education in India refer to various resources and assistance programs provided to students from historically marginalized or underrepresented groups to ensure their participation, academic success and retention in colleges and universities. It can be provided by various entities, including central and state governments, educational institutions, non-profit organizations, and private companies or foundations, all working to ensure the success and well-being of students. These services aim to address the unique challenges and barriers faced by these student groups and promote their equitable participation in higher education. Examples of support services may include:

#### 1.6.5.1. Financial support services and scholarships:

To provide financial support services in educational institutions to students from marginalised or disadvantaged groups. Assisting students in accessing financial aid resources, including scholarships, and grants to help alleviate financial barriers to higher education. Scholarships refer to one of the financial aid programs within the context of affirmative action in higher education, specifically designed to support individuals from these groups who are underrepresented in education. The scholarships are often targeted towards students who demonstrate academic potential but may face financial barriers to accessing higher education. The aim of such scholarships is to increase the representation of disadvantaged groups in colleges and universities by providing financial support to help offset the costs of tuition, books, and other educational expenses. Scholarships may be awarded based on the factors such as socioeconomic background, caste, religion, gender, and geographic location to promote diversity and equity within educational institutions. Specifically, students from economically weaker sections in every engineering institute in India, whose family annual income is less than 2 lakhs, can apply for financial aid. There is greater provision of government scholarships for women in higher education, including engineering education, perhaps with the aim of increasing their participation in this field. Additionally, merit-based scholarships may also be

awarded to outstanding students as a means of encouragement and recognition for their academic achievements.

Apart from government agencies some private companies or charitable foundations also provide support services like scholarships, donations to support students in higher education, especially those from disadvantaged backgrounds. Some charitable organizations provide direct financial assistance to prestigious engineering institutions, specifically targeting enhancement of facilities and addressing the challenges faced by Scheduled Castes and Scheduled Tribes.

#### 1.6.5.2. Providing loans:

The government provides loans to undergraduate and postgraduate students, primarily aiming to provide financial assistance for the purchase of textbooks and study materials. This initiative targets high-cost fields of education such as engineering and medicine.

#### 1.6.5.3. Outreach programs:

Outreach programs, as one of the support services refer to initiatives designed to engage and support individuals from underrepresented or marginalized groups in accessing educational opportunities. These programs typically involve activities such as informational sessions, workshops, advisory programs, campus tours, and community events aimed at reaching to prospective students from diverse backgrounds. The goal of outreach programs is to increase awareness about higher education options, provide support and guidance throughout the application process, and ultimately improve the representation of historically disadvantaged groups in colleges and universities.

#### 1.6.5.4. Providing textbooks and stationery items:

The government provides textbooks to students from marginalised groups of medical and engineering courses, textbooks related to medical and engineering courses are generally expensive and beyond their purchasing power. Actually, they suffer in studies compared to students from other communities who are economically better off. To overcome this handicap, a scheme for providing grants to various institutions for the purchase of medical and engineering books was introduced in 1974–75. Under this scheme, funds are being distributed between the Central and State Governments on 50/50 basis. Thus, the books purchased are kept in libraries for the exclusive use of students belonging to the marginalised groups. Under this scheme, one set of books is given to two students at the undergraduate level, and one set to one

student at the postgraduate level. In addition, stationery items are provided by the institutions to students from deprived or marginalized sections, with the aim of boosting their academic achievements.

**1.6.5.5. Tutoring and academic mentoring**:

Providing additional academic support to students who may need extra assistance to succeed in their coursework.

**1.6.5.6. Access to technology and resources**:

Ensuring that students have access to necessary technology, such as computers and internet connectivity, as well as academic resources like libraries and research materials.

**1.6.5.7. Counselling and guidance**:

Offering counselling services to address personal, academic, or career-related concerns and help students navigate their educational journey.

**1.6.5.8.Career development and placement assistance**:

Offering career counselling, placement services, and networking opportunities by the institutions to help students transition from education to employment.

**1.6.5.9. Special hostel facility:**

Creation of special hostels to provide residential facilities in institutions for girls and other specific categories like foreign students, economically weaker section students, specific religion or caste-based students, and physical disability students.

**1.6.5.10. Disability support services**:

Providing accommodations and resources for students with disabilities to ensure equal access to educational opportunities and facilities.

**1.6.5.11. Cultural and affinity groups**:

Establishing student organizations or affinity groups to foster a sense of belonging and community among students from diverse backgrounds. It may provide support services such as mentorship programs, counselling, and advocacy for specific student populations, including castes, gender, minorities, low-income students, or individuals with disabilities.

**1.6.5.12. Special employment cell:**

A special employment cell has been set up in the directorate of welfare of scheduled castes and backward classes, to register the names of unemployed educated persons of these classes throughout the state, who have certificates in respect of educational and technical qualifications. Even those scheduled caste persons who had already registered their names in the employment exchange were made eligible to register their names in the Special Cell. The

employment cell along with the employment exchange continues its normal efforts to find jobs for such scheduled castes and backward classes candidates as against the general vacancies.

#### 1.6.5.13. Exclusive scholarships for study in abroad:

The government provides specific scholarships and passage grants to students for higher education abroad. Selective scholarships are provided especially in the field of engineering education if a student pursues education in a technologically advanced country.

#### 1.6.5.14. Student Welfare (SW) Fund:

Each institute also has a Student Welfare (SW) fund to address the problems faced by the students. It focuses more on meritorious students, students from economically weaker sections and marginalised groups.

Overall, support services play a vital role in promoting the participation, academic success, retention, and overall well-being of students from marginalized or disadvantaged groups in higher education in India. The aim is to create an inclusive and supportive learning environment where all students can succeed and reach their full potential.

Apart from the affirmative actions mentioned earlier, some state governments have also been providing some specific measures of reservation on the welfare of socially backward groups (SC, ST and OBC). Here are some of them:

## 1.7. Reservations in Engineering Education by Specific State Government

Some states in India have implemented state-specific reservations in the education sector. These reservations cater to the specific needs and social dynamics of the respective states, address regional disparities and promote inclusive education. State-specific measures and programs of reservation in the education sector aim to provide equal opportunities for socially backward groups, bridge educational gaps, and promote social inclusivity. By ensuring representation and access to quality education, these initiatives contribute to the overall development and empowerment of disadvantaged or marginalized communities in India. State-specific reservations in the education sector in India vary across different states based on their respective policies and socio-political contexts. Here are some examples of state-specific reservations with percentage details:

1. Tamil Nadu: Tamil Nadu has a long-standing history of implementing reservations in educational institutions. The state provides a unique reservation policy known as "Tamil Nadu Reservation Policy." As per this policy, a 69% reservation is implemented in educational institutions, which includes reservations for various categories such as Scheduled Castes (18%), Scheduled Tribes (1%), Most Backward Classes (20%), Backward Classes (26.5%), and Denotified Communities (7.5%).
2. Maharashtra: In Maharashtra, reservations in educational institutions are implemented as per the Maharashtra State Reservation Act. The reservation percentages for different categories are as follows: Scheduled Castes (13%), Scheduled Tribes (7%), Vimukta Jati and Nomadic Tribes (29%), Other Backward Classes (19%), and Special Backward Classes (2%).
3. Andhra Pradesh: Andhra Pradesh provides reservations under the Andhra Pradesh Reservation of Seats in Educational Institutions Order, 1974. The reservation percentages for various categories are as follows: Scheduled Castes (15%), Scheduled Tribes (6%), and Backward Classes (29%). Additionally, a 33.33% reservation is provided for women in each category.
4. Karnataka: Karnataka has implemented reservations under the Karnataka Scheduled Castes, Scheduled Tribes, and Other Backward Classes (Reservation of Seats in Educational Institutions in the State) Act, 1990. The reservation percentages for different categories are as follows: Scheduled Castes (15%), Scheduled Tribes (3%), Category I (4%), Category II A (15%), Category II B (4%), Category III A (5%), and Category III B (4%).
5. In Bihar, 75% of seats are reserved for Scheduled Castes (SC), Scheduled Tribes (ST), and Other Backward Classes (OBC) in appointments.

The reservation percentages mentioned here are specific to the respective states. Delhi does not have state-specific reservation policies for socially backward groups (SC, ST, and OBC); instead, the reservation policies of the Central Government apply to educational institutions in the region, including central universities or institutions, state government institutions, and other educational establishments. In the context of engineering education in Delhi, alongside central government reservation policies for SC, ST, and OBC student groups, several specific reservation policies exist for other groups, and various affirmative actions are also available for students. These specific reservations and affirmative actions in engineering institutions for different groups are mainly administered by the institutions based on state government policies

and social and economic considerations. However, the specific kinds of reservation policies and affirmative actions among engineering institutes in Delhi can differ based on guidelines set by the state government and the decisions made by the institutions themselves. Specifically, this study emphasises the discussion of reservation policies and other affirmative actions in degree-level engineering institutions in Delhi. The study provides an in-depth overview of undergraduate-level engineering education in Delhi in Chapter 4, with emphasis on the different institutions and their respective reservation policies and other affirmative actions. Additionally, it is essential to evaluate the dynamics, effectiveness, and opportunities to enhance these policies in engineering education. As well, it is important to assess the strengths of the current reservation system and identify strategies to increase its impact on socio-economic mobility and educational achievements. Hence, a comprehensive analysis focused on reservations under affirmative actions in higher education, particularly in engineering, is warranted, to assess its effectiveness on marginalized or disadvantaged groups and identify areas for improvement.

The study exclusively focuses on reservation policies in enrolment for Scheduled Tribes (ST), Scheduled Castes (SC), and Other Backward Classes (OBC) as a form of affirmative action. These policies have been implemented by the Government of India since the very beginning with quotas of 7.5%, 15% and 27% respectively for undergraduate courses, with the objective of enhancing the educational conditions of these marginalized groups. Specifically examining students enrolled in undergraduate engineering courses at Delhi in the academic year 2015-16, the study analyses the status of SC, ST, and OBC engineering students, enrolled through these quotas, when other admission quotas like EWS and women quota were not implemented. It also examines the status of minorities in engineering education, as the study area Delhi has notably three minority engineering institutions alongside several prestigious engineering institutions. Indeed, Minorities have equal rights to access educational opportunities and pursue higher education, addressing their specific needs and challenges effectively. Additionally, Article 30 of the Indian Constitution ensures that minority communities have the right to establish educational institutions of their choice. Within these institutions, they have the autonomy to set admission policies and may prioritize students from their respective religious communities. Despite these provisions, they remain underrepresented in higher studies, particularly in engineering. Hence, the study aims to examine their status in engineering education in light of these rights. Furthermore, the study also analyses the status of women belonging to both these marginalized communities (socially backward castes and religious

minorities). It adopts an inclusive approach to understand gender disparities within these groups in the context of engineering education. In fact, Delhi has one engineering university exclusively for women, and several gender-based affirmative actions have been implemented in higher education to address gender disparities, given the remarkably low participation of women in engineering. Overall, the study has assessed the status of SC, ST, OBC, minorities and women students in engineering education.

## 1.8. Rational of the Study

Out of the above discussed affirmative actions, the reservation policies in education and establishment of special institutions for minorities and women have always remained a subject of considerable discourse and scrutiny, particularly in the context of engineering education. It is a great opportunity for all those who are supporting it. However, it leads to mediocrity for those who are against it. There is a paucity of serious studies on those who have joined engineering education through reservation. In this background, there is an urgent need to study the socio-economic and demographic background of the students admitted through reservation and other special measures. The study tries to fill the gap. Again, it is of utmost importance to investigate how they perform after joining the institutions. This study does the same through capturing their cumulative grade point average (CGPA). Recruitment through placement cell and the salaries offered to them are also a reflection of the students' knowledge, understanding and ability to apply the acquired skills. The study also capturers information on these aspects.

In this context, the study explores the status of students from Scheduled Castes (SC), Scheduled Tribes (ST), and Other Backward Classes (OBC) after their enrolment in engineering institutions. In addition, the study investigates the status of minorities as well. As part of the study, both the groups were further examined on the basis of gender. By highlighting the potential advantages and limitations of reservation, this study intends to provide valuable insights to policy makers, educational institutions and other stakeholders, which can help in enhancing equitable access and quality in engineering education.

## 1.9. Organisation of the Thesis

The subsequent chapters of the thesis are structured as follows:

### 1.9.1. Chapter 2:

It gives a comprehensive review of the existing literature on (i) SC, ST and OBC students in engineering education, (ii) Minorities in engineering education and (iii) women in engineering education. It gives the existing research gap for the study.

### 1.9.2. Chapter 3:

It provides an overview of the objectives and hypothesis of the study. The detailed discussion on the sample design and methodology applied for collection of data has also been given. Both descriptive statistics and inferential statistics have been discussed in this chapter.

### 1.9.3. Chapter 4:

The chapter discusses in depth the reservation policies and other affirmative actions adopted by degree-level engineering institutions in Delhi. Following this, a comprehensive discussion on the socio-demographic and economic analysis of the respondents has been conducted through descriptive statistics.

### 1.9.4. Chapter 5:

It analyses the academic performance and labour market outcomes of engineering graduates admitted through reservations, namely Scheduled Castes (SC), Scheduled Tribes (ST), and Other Backward Classes (OBC). While there are no universal reservations for minorities and women, exclusive institutions are available for them. Additionally, some institutions provide reservation for single girl child. Similar analysis has been done for minorities and women through inferential statistics i.e. the ordinary least squares (OLS) method, and the Heckman selection method.

### 1.9.5. Chapter 6:

It provides a summary of the major findings, key concerns, and policy implications derived from the study. Additionally, it clearly specifies the limitations of the research and suggests possible avenues for future research.

## 1.10. To Sum up the Chapter

In brief, the first chapter introduces the discussion on the beneficiaries of affirmative programs, such as socially backward caste groups who benefited from reservation policies in enrolment, as well as minorities and women who benefited from special institutions established for them. It discusses in depth socially backward groups, religious minorities and women in engineering education in India. The various affirmative actions in engineering education and the rational of the study have also been discussed in the chapter. At the end, organisation of the rest of the thesis has been given.

# CHAPTER -2
# REVIEW OF LITERATURE

## 2.1 Background

The chapter provides a comprehensive review of the available literature on marginalized groups i.e. Scheduled Castes, Scheduled Tribes, Other Backward Castes, religious Minorities and women in engineering education, their academic performance and labour market status. The review helps to identify the research gaps and finally, to establish objectives for the study. Specific keywords, as “Schedule Caste (SC), Schedule Tribe (ST), and Other backward caste students (OBC) in engineering education”, "minorities in engineering education", “women in engineering education", were carefully chosen and constructed into search strings which was used to obtain relevant literature from a diverse range of electronic databases, such as Google Scholar, Emerald, Science Direct, Springer, Wiley Online, Sage, and books within the domain. Where sufficient literature related to engineering education was not found, the search was expanded by replacing engineering education with higher education. The gathered literature was taken to a filtering process that involved analysing the titles of the articles, followed by a thorough examination of their abstracts. By applying this approach, the literature was effectively screened and organized into relevant groups for a more systematic examination. The review of existing literature has been given in flowing three sections, i.e. from 2.2 to 2.4.

## 2.2. Scheduled Caste (SC), Scheduled Tribe (ST), and Other Backward Caste (OBC) students in Engineering Education

Higher education serves as a crucial factor in empowering communities and individuals in society, with engineering education being increasingly perceived as an investment in human capital globally (Psacharopoulos & Patrinos, 2018; De Freitas, 2018; Thomas, 2018). It also serves as an important tool for the development of socially and economically disadvantaged groups, offering avenues for economic growth, self-confidence, and flexibility (Shah, 2017; Behera, & Mathew, 2022). Participation in engineering and technical education not only contributes to national development but also enhances the well-being of communities by

positively impacting employment opportunities and earnings (Ritz & Bevins, 2012; Tilak, 2020).

In India, Scheduled Castes (SCs), Scheduled Tribes (STs), and Other Backward Classes (OBCs) represent socio-economically disadvantaged groups facing barriers to full societal participation (Shah, 1991). Students in these groups often face greater socio-economic challenges compared to their counterparts, limiting their educational attainment and hindering academic success, leading to missed employment opportunities. Women from these marginalized groups face a dual disadvantage due to their gender and social status (McCafferty, 2022; Yan, & Gai, 2022; Jamatia, 2023). Additionally, SC and ST students struggle with cultural mismatches between institutions and family environments, leading to discipline issues and academic disengagement. The challenges faced by these students are further compounded by limited employment prospects due to caste barriers (Sarkar, 2023). Factors such as poverty, unemployment, and societal discrimination contribute to the educational difficulties experienced by SC, ST, and OBC students in India (Rathod, 2023).

To address this, the Government of India implements affirmative action measures, including reservations in education and public employment for OBC, SC and ST students. The national policy of reservation aims to provide representation to these historically marginalized groups (De Zwart, 2000; Biswas, 2018; Kumar et al., 2020; Kumar, 2022). Despite the existence of reserved seats in educational institutions for disadvantaged caste groups, their representation in higher education, especially engineering and technical education remains significantly low. It is noteworthy that the share of females of these caste groups in engineering education is very less (Chalam,1990; Weisskopf, 2004; Dinesha,2015; Subramanian, 2019). Research increasingly highlights these gaps in STEM education, especially at prestigious institutions like the Indian Institutes of Technology (IITs). Additionally, emphasize the need for gender-just affirmative action policies to address the unequal access and participation in STEM fields, including engineering (Amirtham, & Kumar, 2023; Kumar, & Sahoo, 2024). The few studies exploring the perceptions of students from rural areas of these marginalized groups towards engineering education and profession reveal significant differences in aspirations and attitudes, indicating the need for interventions to promote inclusivity (Ayisha, et al., 2022; Subheesh, et al., 2023).

However, studies have shown that reservation in higher education has been successful to some extent in increasing access to education for the marginalised sections of the society. It found

that SC and ST students were under-represented in higher education institutions in India and reservation played an important role in increasing their representation (Samraj, 2022; Behera, & Mathew, 2022; Mohanan, & Netto, 2023; Arora, 2023). Ultimately, reservation in higher education has a positive impact on the economic mobility of students from disadvantaged backgrounds (Sharma, 2022; Webster, 2022). After lot of efforts there has been visible progress in the participation of SC, ST and OBC students in higher education including engineering and technology, but the share is not satisfactory compared to the national enrolment rate (Malhotra & Shekhar, 2013; Rahaman, 2021).

In fact, students from SC, ST and OBC communities tend to show lower levels of interest and confidence in pursuing engineering careers, because students from these groups who are considering a career in engineering face different types of difficulties in entering this field. As a result, during their college education, they fill slightly distinct co-operative positions and become less likely to participate in engineering-related activities (Tierney, et al., 2019; Kumar, 2021; Dhaktode, 2021; Dasgupta, *et. al.,* 2023). In addition, socially backward students' socioeconomic status makes it difficult for them to prepare for engineering entrance exams, and to afford the high costs of engineering education (Pai, 2000; Kumar, 2016; Neog, 2018; Major, & Godwin, 2018; Ansari, 2022; Haflongber, 2022).

It is unfortunate that students from these social caste groups (SC, ST and OBC), who enrol in engineering education, often face challenges in adapting to the academic environment and do not achieve good academic performance (Rathod, 2019; Narwana & Gill, 2020). Students from these groups often face discrimination and bias in the University/institution campuses, which leads to poorer academic performance in engineering education. Discrimination takes many forms, including overt bias by faculty and administrators, subtle microaggressions by peers, and institutional bias in admissions and evaluation processes (Henry, & Ferry, 2017; Pathania, et al.,2023). Furthermore, socially disadvantaged students tend to perform poorly in engineering education compared to students from more privileged backgrounds (Malhotra & Shekhar, 2013; Verma,2013). Students belonging to SC, ST and OBC communities generally come from lower socio-economic backgrounds and often face a number of challenges that affect their academic performance (Munir, et al., 2023; Vadivel, et al., 2023). These problems may also be related to financial constraints, lack of access to resources such as books and technology, and inadequate educational opportunities, etc. This makes it difficult for them to keep pace with the tough curriculum required in engineering programs, consequently students from these groups tend to have lower academic performance. The studies highlight the need for

targeted interventions to address these challenges and promote inclusive learning environments for SC, ST and OBC students (Neog, 2018; Das, 2019; Patil, 2021; Sabharwal, 2021). Several studies also highlight the positive impact of parental education on the academic achievements of socially disadvantaged student groups (Şengönül, 2022; Utami, 2022).

Another important factor that affects the academic performance of socially disadvantaged students in engineering education is their level of preparedness for college-level coursework. Mental pressure is also an important factor that affects many students during their college education. The pressure to excel academically and conform to social norms often leads to feelings of stress, anxiety, and depression (Arora & Singh, 2017; Jasubhai, 2023). In fact, many socially disadvantaged students do not receive adequate preparation in secondary education, leading to difficulties in adapting to the rigor of college-level engineering courses. Furthermore, students from these caste groups (SC, ST and OBC) mostly come from non-English speaking backgrounds, making it difficult for them to keep up with the curriculum and perform well in examinations at the institutional level (Olufemi *et al.,* 2018; Thiry, 2019; Ngqondi, & Mauwa, 2019; Kumar, 2021; Sabharwal, 2021). Moreover, the role of institutional factors, such as the quality of teaching, availability of academic support, college environment, behaviour of teacher and staff, and mentorship programs also significantly impact the academic success of socially disadvantaged students (Loyalka *et al.,* 2014; Rathod, 2019; Sukumar, 2022; Sharmin, et al., 2022).

Other factors include the impact of gender and caste on academic performance, as well as the role of socio-cultural norms and values in shaping student attitudes toward education (Lynch, 2016; Narwana & Gill, 2020; Sharmin, et al., 2022). A study shows that caste significantly affects academic performance, with lower caste categories not necessarily correlating with lower performance, especially among those with the lowest economic status. Moreover, the effect of gender varies between individuals of different castes, while men from the lowest caste exhibit the worst performance, it is women from this caste who experience the highest levels of segregation. The study highlights that higher-income SC/ST students do not benefit academically, possibly due to societal capital disparities. SCs/STs also exhibit the lowest self-esteem and self-efficacy, which are influenced by educational background and quota system effects (Gupta, 2019). However, Borooah, & Iyer, (2005) argued that socio-economic conditions influence the impact of caste on the individual. When there are favourable circumstances, the impact of caste is minimal and in unfavourable circumstances the impact

becomes substantial. The study's finding that socio-economic circumstances, such as parents' education, influence the degree of impact of caste on an individual's education.

In general, the academic performance of students plays an important role in determining their employability and success in their chosen profession, whereas in disadvantaged groups, low academic performance affects their personal development by limiting employment opportunities (Tentama & Abdillah, 2019; Manjunath, 2021; Chatterjee, & Burns, 2021). It is widely recognized that educational performance is the most significant indicator and effective tool for employment of any community in the society (Sencan, & Karabulut, 2015; Lanzarini, et al., 2015). When it comes to socially disadvantaged students in higher education, especially in engineering or technical education and employment in this sector, they face greater vulnerabilities than other groups. Which hinders their ability to fully participate in education and excel in academics, leading to loss of their employment opportunities. This is a discouraging aspect of their career and personal development (Dunn, 1993; Mahadevaswamy, *et.al.*, 2013; Sabharwal & Malish, 2018; McCafferty, 2022). The study by Henry and Ferry (2017) revealed that general category students have higher job placement rates compared to the socially backward caste groups. Specifically, 90% of GEN students secured jobs compared to 77% of OBCs, 68% of SCs, and only 46% of STs. Furthermore, the study indicates that graduating from more selective departments leads to higher job placement rates, regardless of admission status and students' scores. However, the disparity between students from the general category (GEN) and socially backward groups (OBC, SC, ST) persists, with greater disparities being evident in less selective departments. Moreover, among students with equal CPI (Cumulative Performance Index) scores, these disparities are most significant in less selective streams, particularly for those with the lowest CPI scores. However, support mechanisms play a vital role in helping these students navigate the complexities of the job market and establish themselves in the engineering profession (Escoda, et al., 2019; Bhagat et al., 2020; Dhotrekar, 2022).

Studies have extensively examined wage disparities and the impact of education on earnings among different social groups in India. Research shows that the wage gaps are significant between forward castes (FC) and backward castes (BC) (Gupta and Kothe,2022). The study also emphasizes the effect of education-occupation match on wage dispersion, showing that more educated workers suffer a wage penalty (Bahl, & Sharma, 2021). Researchers discuss the wage differentials among professionally trained youth, noting the prevalence of barriers to upward mobility for Backward Castes (Das, 2018). These studies collectively underline the

existence of wage gaps and the complex relationships between educational achievement, social identity and earnings in India. Some studies have explored the influence of educational attainment on the earnings of socially disadvantaged groups as well as highlighted the existence of wage gaps (Maji, & Sarkar, 2018; Goswami, 2022; Ray Chaudhury, et al., 2023; Baiju, 2023). Researchers also highlight the importance of factors such as discrimination and limited career prospects in shaping the earnings gap, and advocates targeted interventions to address disparities in earnings (Deshpande, & Sharma, 2016; Dash and Bosel, 2020; Kumar, & Hashmi, 2020). A study analyses student placement rates based on admission status groups as well as examines salary disparities. The analysis shows that being categorized as OBC, SC and ST decrease the likelihood of earnings between Rs 6.5 to 11 lakh compared to general students. Additionally, it highlights that the probability of earning above Rs 11 lakh is significantly reduced, particularly for ST students (Henry and Ferry, 2017).

Consequently, these classes are eligible for specific benefits and privileges, such as reservations in education as well as in the job market (Weisskopf, 2004; Dinesha, 2015; Kumar, *et al.*, 2020). Additional affirmative actions have also been implemented to improve their participation in higher education, including engineering, and in employment. These positive programs are specifically designed to address historical inequalities and provide opportunities to students from disadvantaged backgrounds (Haq et al., 2020; Munusamy, 2022; Ahmad, 2022; Schotte, et al., 2023). It helps the students from underrepresented communities to gain access to quality education as well as employment. Such inclusion fosters a rich learning environment that also enhances cross-cultural interaction and understanding (Richardson, & Dinkins, 2014; Haokip, 2019; Bhagat et al., 2020). Nevertheless, not all researchers have the same opinion on the consequences of such affirmative action. Some researchers have discussed that with the presence of reservations in engineering and technical education for disadvantaged groups, sometimes their participation is even less than the quota stipulated by the Constitution (Dinesha,2015; Sönmez, & Yenmez, 2019; Rahaman, 2021; Behera, & Mathew, 2022; Sunar, 2022). There may be many reasons for these observed disparities in engineering education, including socioeconomic barriers, cultural factors, and historical disadvantage. In contrast, there has been a significant increase in their participation in fields related to the liberal arts and humanities (Bertrand et al., 2010; Dinesha,2015; Kumar, 2021). Researchers suggest that there is insufficient exploration of the issue of caste in the field of educational equity in terms of both process and outcome dimensions. Based on ethnographic accounts of the educational experience of scheduled caste engineering students, they discuss how institutional cultures are

of great importance to students from marginalized groups. They also propose a more comprehensive investigation into this matter (Malish and Ilavarasan, 2016). Indeed, some argue that reservation policies may compromise merit and give rise to the perception of preferential treatment. As a result, reservation in engineering education sometimes faces criticism and challenges. Researchers have also discussed the need for a more holistic approach of affirmative action, addressing socio-economic factors beyond caste-based reservations (Dhotrekar, 2022; Chakrabarty, 2022, Sharma, 2022; Sethuraman, 2023; Varghese, & Jose, 2023).

**Table-2.1: Brief literature on Scheduled Caste (SC), Scheduled Tribe (ST), and Other Backward Caste (OBC) students in engineering education**

| Authors/Years | Findings |
|---|---|
| Psacharopoulos & Patrinos, 2018; De Freitas, 2018; Thomas, 2018 | Higher education empowers communities and individuals in society that perceive engineering education as an investment in human capital. |
| Shah, 2017; Behera, & Mathew, 2022 | Higher education is an important tool for social and economic growth offering self-confidence and flexibility. |
| Ritz & Bevins, 2012; Tilak, 2020 | Higher education enhances the well-being of communities, national development, and positively impacts employment opportunities and earnings. |
| Shah, 1991; McCafferty, 2022; Yan, & Gai, 2022; Jamatia, 2023 | SC, ST and OBC face numerous barriers to full societal participation. They face socio-economic challenges including women who face dual disadvantage due to gender and social status. |
| Sarkar, 2023; Rathod, 2023 | Factors like poverty, unemployment, and societal discrimination contribute to educational difficulties of SC, ST and OBC students. They have limited employment prospects due to caste barriers. |
| De Zwart, 2000; Biswas, 2018; Kumar et al., 2020; Kumar, 2022 | GOI implements affirmative actions, like reservation in education and employment for the development of OBC, SC and ST students. It aims to provide representation to these historically marginalized groups |
| Chalam,1990; Weisskopf, 2004; Dinesha,2015; Subramanian, 2019 | Even after reservation, very less participation of SC, ST and OBC in higher education, especially engineering. |
| Amirtham, & Kumar, 2023; Kumar, & Sahoo, 2024 | Gender-just affirmative actions need for unequal participation in STEM fields, including engineering. |
| Ayisha, et al., 2022; Subheesh, et al., 2023 | Students from rural areas of these marginalized groups towards engineering education and profession reveal significant differences in aspirations and attitudes. |

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| Samraj, 2022; Behera, & Mathew, 2022; Mohanan, & Netto, 2023; Arora, 2023 Sharma, 2022; Webster, 2022 | Reservation helped in increasing their representation in education to some extent. It has also a positive impact on the economic mobility of disadvantaged backgrounds |
| Malhotra & Shekhar, 2013; Rahaman, 2021 | Visible progress seen in participation of SC, ST and OBC in higher education, but not satisfactory. |
| Tierney, et al., 2019; Kumar, 2021; Dhaktode, 2021; Dasgupta, *et. al.*, 2023 | SC, ST and OBC students showing less interest and confidence in engineering-related activities. |
| Pai, 2000; Kumar, 2016; Neog, 2018; Major, & Godwin, 2018; Ansari, 2022; Haflongber, 2022 | Socioeconomic status makes it difficult for them to prepare for engineering entrance exams and afford further studies. |
| Rathod, 2019; Narwana & Gill, 2020 | Socially backward castes face challenges in adapting to the good academic environment. |
| Henry, & Ferry, 2017; Pathania, et al.,2023 | Discriminations including administrators' bias, subtle microaggressions by peers, and institutional bias in admissions and evaluation processes discourage socially backward caste students. |
| Malhotra & Shekhar, 2013; Verma,2013 | Socially backward caste students perform poorly in engineering education compared to students from more privileged backgrounds. |
| Munir, et al., 2023; Vadivel, et al., 2023 | Socially backward castes face several challenges that affect their academic performance. Generally, they come from lower socio-economic backgrounds. |
| Neog, 2018; Das, 2019; Patil, 2021; Sabharwal, 2021 | Problems related to financial constraints, lack of access to resources such as books and technology, and inadequate educational opportunities, etc., makes difficult for SC, ST and OBC students to keep pace with the tough curriculum required in engineering programs, consequently students tend to have lower academic performance. |
| Şengönül, 2022; Utami, 2022 | Positive impact of parental education on the academic achievements of disadvantaged students. |
| Arora & Singh, 2017; Jasubhai, 2023 | Pressure to excel in academics also leads to stress, anxiety, and depression for socially backward caste students |
| Olufemi *et al.*, 2018; Thiry, 2019; Ngqondi, & Mauwa, 2019; Kumar, 2021; Sabharwal, 2021 | English curriculums make it difficult to perform well in examinations at the institutional level. |
| Loyalka *et al.*, 2014; Rathod, 2019; Sukumar, 2022; Sharmin, et al., 2022 | Institutional factors, like quality of teaching, availability of academic support, college environment, behaviour of teacher and staff, and mentorship programs significantly impact the academic success of students. |
| Lynch, 2016; Narwana & Gill, 2020; Sharmin, et al., 2022 | Impact of gender, caste and socio-cultural norms on academic performance, and shaping student attitudes toward education. |

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| Gupta, 2019 | Higher-income SC/ST students do not benefit academically, due to societal capital disparities, also they exhibit lowest self-esteem and self-efficacy. |
| Borooah, & Iyer, 2005 | The impact of caste is minimal and, in unfavourable circumstances, becomes substantial. Socio-economic circumstances, such as parents' education, influence the degree of impact of caste on an individual's education |
| Tentama & Abdillah, 2019; Manjunath, 2021; Chatterjee, & Burns, 2021 | Low academic performance affects their personal development by limiting employment opportunities. |
| Sencan, & Karabulut, 2015; Lanzarini, et al., 2015 | Educational performance is the most effective tool for employment. |
| Dunn, 1993; Mahadevaswamy, *et.al.*, 2013; Sabharwal & Malish, 2018; McCafferty, 2022 | Socially backward caste faces greater vulnerabilities that hinders their ability to perform well in education or academics, leading to loss of their employment. |
| Escoda, et al., 2019; Bhagat et al., 2020; Dhotrekar, 2022 | Disparity persists between general and socially backward students. It is most significant in less selective streams, particularly for those with the lowest CPI scores. |
| Gupta and Kothe,2022 | The wage gaps are significant between forward & backward castes. |
| Bahl, & Sharma, 2021 | More educated workers suffer a wage penalty. |
| Das, 2018 | There is wage difference among professionally trained youth noting caste barriers. |
| Maji, & Sarkar, 2018; Goswami, 2022; Ray Chaudhury, et al., 2023; Baiju, 2023 | Influence of educational attainment on earnings of marginalized groups as well as the wage gaps. |
| Deshpande, & Sharma, 2016; Dash and Bosel, 2020; Kumar, & Hashmi, 2020 | Discrimination and Limited Career Prospects are important factors in shaping the earnings gap. |
| Henry and Ferry, 2017 | General category students have higher job placement rates and higher earnings compared to the socially backward caste groups. |
| Weisskopf, 2004; Dinesha, 2015; Kumar, *et al.*, 2020 | So, they are eligible for privileges like reservations in education as well as in the job market. |
| Haq et al., 2020; Munusamy, 2022; Ahmad, 2022; Schotte, et al., 2023 | Various affirmative programs are designed to resolve historical inequalities and provide opportunities to students from disadvantaged backgrounds. |
| Richardson, & Dinkins, 2014; Haokip, 2019; Bhagat et al., 2020 | The inclusions foster a rich learning environment that also enhances cross-cultural interaction and understanding. |
| Dinesha,2015; Sönmez, & Yenmez, 2019; Rahaman, 2021; Behera, & Mathew, 2022; Sunar, 2022 | Sometimes, the participation of socially backward castes are less than the stipulated quotas. |

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| Bertrand et al., 2010; Dinesha,2015; Kumar, 2021 | Disparity is observed in engineering education, in contrast, participation increased in humanities to some extent. |
| Malish and Ilavarasan, 2016 | Institutional cultures/environment are also important to students from marginalized groups. |
| Dhotrekar, 2022; Chakrabarty, 2022, Sharma, 2022; Sethuraman, 2023; Varghese, & Jose, 2023 | Need for a more holistic approach of affirmative action, addressing socio-economic factors beyond caste-based reservations. |

## 2.3 Minorities in Engineering Education

The empowerment and progress of any community, including minorities, can be enhanced through increasing levels of education and training, which ultimately leads to inclusive growth. Higher level education is required for living a decent and respectable life in the society, as well as beneficial in finding employment and earning money to support the lifestyle. Also, it is widely recognized that higher education is the most important indicator and effective tool for empowering marginalized communities within the society (Edgerton, *et al*., 2011; Noor, 2016; Behera, & Mathew, 2022). Religious minority groups in India, particularly Muslims, are often considered marginalized or deprived as they frequently face various socio-political and economic challenges, as well as discrimination, which hinders their educational advancement and employment opportunities (Khanumn, & Hussain, 2022; Malik, 2023). The minority population (Muslims, Sikhs, Christians, Buddhists, Jains and Parsis), constitutes about 20% of the total population of the country and the rest are Hindus. Among minorities, Muslims are the largest group with about 14.2% (GOI, 2011; Thorat & Ahmad, 2015; Thorat, 2022). Given this remarkable contribution of minorities to the Indian society, education for minorities is important, as it plays a vital role in the all-round development of an individual as well as a group of individuals (Narula, 2014; Noor, 2016; Terziev, 2022; Panakaje, 2022).

In particular, it is necessary to improve their participation in higher education, including engineering and technology, where they are extremely underrepresented (Khan and Butool, 2013; Mir, & Pramanik, 2017; Malik, 2023; Midya, & Islam, 2024). Indeed, engineering and technical education is not only a substantial aspect in development of the nation; it helps in improving the lives of any community as it has a direct impact on employment and earnings (Gupta, & Dewanga, 2012; Tilak, 2020). In view of the low representation of minorities in this field, some researchers argue that there is a need for reservation for minorities in education to

promote greater diversity and inclusion within the field. Several studies also emphasize the necessity of targeted policies to address the underrepresentation of minorities in higher education (Narula, 2014; Shariff, 2023; Kim, 2023). On the other hand, opponents have expressed concerns about potential challenges in defining criteria and eligibility for reservations, as well as the implications of merit-based selection (Sönmez, & Yenmez, 2019; Chakrabarty, 2022; Veeresha, 2022; Sardoč, 2022; Babu, *et.al*, 2022).

The empowerment of minorities in India in the present situation requires education in general, higher and technical education in particular, and the country would progress automatically if all communities are educationally empowered to efficiently take part in the development process and enabled to share the fruits of growth and prosperity (Noor, 2016; Dar, et.al, 2022; Saif, & Kumar, 2023). Minorities often face challenges related to socio-economic, religious and gender factors, and experience a distinct form of social deprivation, resulting to significant backwardness in terms of various human development indicators (Shazli and Asma 2015; Ur Rehman, et.al., 2020; Malik, 2023). Some studies have explored inter-religious disparities in education in India. It is evident that minorities, especially Muslims, lag behind other groups, which shows the disheartening aspect of their lives. Muslims have the lowest literacy rates, average years of education, secondary schooling, and representation in higher education, compared to other groups in India (Khan and Butool, 2013; Narula, 2014; Hussain *et al.*, 2018; Joshi and Ahir, 2019). Discussing among minority groups, the literacy rate of Muslims is only 57.3%, where 62.41% of males and 51.90% of females are literate, which is far behind the national average literacy rate of 74.4%. In the case of other minorities in India, their literacy levels are higher than that of Muslims. The highest literacy level is found among Jains 86.40%, followed by Christians with 74.30%, Buddhists with 71.80% and Sikhs with 67.50%. This demonstrates that Muslims have the highest illiteracy rate in India, and their literacy has increased from 50.01% to only 51.90% in 10 years (Mollah, & Bera, 2018).

When looking at minority students in higher education, particularly in the field of engineering and technical education in India, it becomes clear that the representation of students from these groups, especially Muslims and Muslim females, is significantly low (Singh, 2012; Khan and Butool, 2013; Khan, 2015). While higher education, including engineering and technology, provides greater opportunities to individuals, encourages active participation in development efforts, and contributes to the socioeconomic and cultural advancement of the society. Moreover, it contributes to fostering economic expansion, enhancing income distribution and

minimizing socioeconomic inequalities, and it is also considered as the prime engine of upward progress of marginalized communities (Joshi and Ahir, 2019; Tilak and Choudhury, 2021). However, some efforts have also been made to attract minority students towards engineering disciplines and increase their participation in this field (Fortenberry, 1994; Huang,2000; Ali and Bagheri, 2009; Singh,2012; Kargarmoakhar and Ross, 2019). Various organizations raise awareness among people about the different schemes implemented by the government. They also support established institutions with community funding to make higher education, as well as engineering education, more affordable. These efforts aim to enhance education at every level, so that individuals develop a positive attitude towards pursuing diverse educational paths like engineering, and entering the labour market. Conceptually, participation in engineering education can increase the likelihood of engaging in employment, with higher the level of education, better the chances of getting a job (Ionescu and Cuza,2012).

Even after considerable recommendations and efforts, the participation rate of minority students in higher and technical education remains low in India. Notably, Muslims in India have the lowest representation among all communities in higher and technical education, further highlighting the slow progress in this sector (Iqbal, 2012; Mir, & Pramanik, 2017; Holthaus, 2023). Despite being the largest minority, Muslims in India consistently perform poorly across various human development indices. They demonstrate lower participation in engineering education compared to all other minority groups, with Muslim female participation rate being the lowest in this field. In contrast, participation rates and the share of women in higher education, including engineering, are higher among all other communities compared to Muslims. It is highest among Jains who account for only less than half per cent (0.4%) of the total population; Christians are in second place, followed by Buddhists, Sikhs, Hindus and Muslims in last place (Khan and Butool, 2013). Indian Muslims are far behind in pursuing higher education because of their economic status, high dropout rates, low chances of educational survival and low interest in education. In addition, sociopsychological aspects, relationship with friends and attitudes of boys and girls, local issues such as high unemployment rates, large magnitudes of immigrants in the local environment are found to be important for this. High drop-out rates after middle school among Muslims are to responsible for the small participation of youth in higher education (Bevelander and Otterbeck, 2010; Basant,2012; Saleem,2021).

Furthermore, the status of women in higher education in Indian society is also very poor, especially Muslim women who lag behind in this field due to many different reasons. It is universally believed that if women of any community remain deprived of education, our society will not be able to develop completely (Allarahamali *et al.,* 2022; Abidi, 2022**).** Gender gap in education is one of the major issues criticizing the policy in the Islamic world, it observed that Muslim girls' education is affected by their religion as Islamic society does not permit girls to be treated at par with boys for pursuing higher education and the society forces parents to withdraw their daughters from education (Jaina be, 2017; Sengupta & Rooj 2018; Abidi & Kazmi, 2019). Remarkably, the drop-out percentage of Muslim girls at the primary level education is less than that of boys, but it increases in higher education. Because, parents do not give enough freedom to Muslim girls to get higher education including engineering and technical education. That is why they have very little access to engineering and technical education. Indeed, Muslim female students in India face many more problems when it comes to higher education (Rekha, 2006; Oplatka and Lapidot, 2012; Kargarmoakhar and Ross, 2019).

The socio-cultural set-up and patriarchal mindsets of our society, which prioritize men over women, are held responsible for the lamentable condition of women in education (Barbhuyan, & Goswami, 2015; Abidi, 2022). The other important factors such as; existence of large families, negative attitude of parents towards girl's education, unawareness about the importance of education, lack of connection between madrasa education and modern education and insecurity of girls are also the main causes for the low participation of Muslim women in higher education (Hussain, *et al.*, 2018; Kapur,2019; Haider, 2021). The personal difficulties met by girls in higher education, difficult to be present in the college during menstrual periods because they don't have the suitable space to change the blemished clothes/pad. It was found that the girls have the fear of sexual abuse and molestation. Usually, Muslim women are discriminated, harassed and discouraged in higher education institutions by male counterparts. The main difficulty of women to enter higher education is the men dominance in the society (Irum *et al.,* 2015; Ashraf and Kumar 2019). Particularly, there are very few Muslim women in engineering education, the main reason for this is the lack of interest or less confidence of women in engineering degree, they feel that engineering education is better for men and unsuitable for women. Also, the lower level of academic support, negative attitude of parents and teachers towards girl's engineering carrier, and girls' willingness to have separate schools/institutions for them are the key reasons of low enrolment of girls in science and

engineering stream (Powell *et al*., 2009; Bock *et al*., 2013; Riegle-Crumb and Moor, 2013; Ahmad, 2014; Merayo, & Ayuso, 2023).

Additionally, discussing the academic performance of minority students in higher education, especially in the field of engineering, is important to understand how diversity plays a role in this field. Various studies have revealed poor academic performance of students from minority groups in higher education (Becerra, et. al., 2023; Tzafea, 2023). In particular, Muslims face a double disadvantage: they have lower levels of education compared to others, and those who enter higher education tend to achieve lower academic performance and experience lower educational quality. (Kotay,2013; Maduwanthi, et.al., 2016; Sabharwal, 2021; Malik, 2023). Low academic achievement of students may be due to lack of academic support, proper environment, teaching or training in colleges/universities. Consequently, their poor academic performance has a negative impact on employment and earnings in the labour market, resulting in increased unemployment among them (Dash and Bosel,2020; Farca, & Gheorghe, 2023). Primarily, their poverty, such as father as the sole earning head of the family, and parents as the only source of financial support, are the major problems of poor academic performance among students. Problems related to educational viewpoint are more syllabus, selection of wrong subject for study, distance education institutes, absence of proper guidance etc (Paul and Das; 2020; Govindarajoo, et.al., 2022; Gutiérrez-de-Rozas, et.al., 2022; Selvarajoo, & Baharudin, 2023). Various studies have emphasized the impact of socio-cultural factors on the academic achievement of minority students in higher education. The studies also focused on the need for targeted interventions to address the specific challenges faced by minority students and reduce the academic achievement gap between them (Oplatka and Lapidot, 2012; Hussain, *et al.*, 2018; Kapur,2019; García-Vita, M. D. M., Medina-García, et.al., 2021). However, research highlighting the challenges and opportunities faced by minorities has also shown that, despite obstacles, students from some minority groups, like Jains and Christians show resilience and achieve remarkable academic success (Khan and Butool, 2013; Alam *et al.*, 2014).

Some studies provide insight into the employment status of minority students, and their experiences in the labour market. They have shown disparities in access to education as well as job opportunities among different religious groups, with specific emphasis on the inequalities faced by Muslims compared to other groups (Ali., 2021; Ali., et.al., 2022; Nazari, 2022; Alesina, et. al., 2023). Researchers have also examined various aspects of the employment outcomes of minority students in higher education. Here, the academic

performance of students along with knowledge and skills plays an important role in enhancing their position in the labour market. This is useful to address better placement and earnings in the job field because during the process of employment with attractive salary packages, employers mainly consider the educational achievement of the students (Carreira, & Lopes, 2017; Wicht, et.al., 2019; Etim, 2023). The educational achievement of minority students may contribute to discrimination in the labour market, as, on average, Muslim students tend to have lower educational performance and competency compared to other groups (Kotay,2013; Balasubramanian, 2020).

Researchers found that minority students, especially Muslims, face a number of additional challenges in securing employment and advancing in their careers. They sometimes face prejudice based on their religion, and negative stereotypes about minority groups affect their hiring (Stevenson, et.al., 2017; Tariq, & Syed, 2018; Srivastava, 2019; Linando, 2024). Minority students often face disparities in educational resources and limited access to professional networks and mentors. These factors contribute to lower academic performance and skill development, consequently affecting their competitiveness in the job market (Razak, et.al.,2021; Etim, 2023). Socioeconomic factors, such as limited financial resources and family obligations, hinder them to pursue necessary training for career advancement (Stevenson, et.al., 2017; Choirudin, et.al., 2022). Limited representation of minority individuals in leadership positions or industries discourages them, creates barriers to their advancement, and perpetuates inequalities in the workplace (Holladay, et.al., 2023; Abulbasal, et.al., 2023; Dalessandro, & Lovell, 2023; Rahim-Dillard, & Johnson, 2023). All of these factors hinder minority students' ability to find job opportunities or career advancement, ultimately leading to problems of unemployment among them. Studies have also emphasized the importance of addressing these barriers to promote equal opportunities for minorities in the workplace. Additionally, they have highlighted the need for targeted initiatives to enhance the professional and personal development of minority students (Pager & Shepherd, 2008; Froy & Pyne, 2011; Sanders, & Orbe, 2017; Wang, & Mo, 2018, Gorman, & Kay, 2020).

Moreover, studies have explored the earnings status of minority students and the disparities they experience. They revealed disparities in earnings among students, with Muslim students earning significantly less than students from other religious groups (Robinson, 2016; Alesina, et.al., 2023; Bhattacharjee, & Roy Chaudhuri, 2023). Researchers have highlighted the significant impact of educational attainment on the earnings of students. It demonstrated the correlation between students' educational attainment and earnings, showing that higher

academic achievements are associated with better job prospects and higher wages. Consequently, the lower academic achievement of Muslim students results in lower earnings (Geetha Rani, 2014; Watts, 2020; Kushwaha, 2023). Socio-economic and cultural factors also influence the earnings of minority students in higher education, particularly in the field of engineering (Rani, 2013; Stevenson, et.al., 2017; Sabharwal, 2021). The study by Watts, (2020) found that educational attainment contributes significantly to earnings, while other factors such as workplace discrimination and limited career advancement opportunities play a pivotal role in shaping the earnings gap (Kumar, & Hashmi, 2020; Forth, et.al., 2023). Lack of institutional support, such as limited career counselling, advanced training, and practical experiences during studies, affects the knowledge and skills acquired, thereby influencing employability and earning potential (Dash and Bosel,2020). The study by Rani (2013) explored the earnings of minorities in higher education, and found that factors such as language of instruction and workplace communication skills influence their financial success in the workplace. Thus, various studies have shown the existence of wage gaps between minority students and their peers in the labour market, and have identified a number of factors affecting earnings in higher education. They also agree that, despite advancements, persistent wage gaps remain and underscore the need for targeted interventions to address these disparities. This emphasizes the importance of ongoing efforts to promote equity in higher education, including in fields such as engineering (Ahmed, 2015; Khattab, 2016; Saleh, 2019; Dubey et al, 2019; Nazari, 2022; Noorjahan, 2023).

**Table-2.2: Brief literature on minority students in engineering education**

| Authors/Years | Findings |
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| Edgerton, *et al*., 2011; Noor, 2016; Behera, & Mathew, 2022 | Higher education is the most important indicator for empowering marginalized communities. |
| Khanumn, & Hussain, 2022; Malik, 2023 | Religious minorities, particularly Muslims, are considered deprived as they frequently face various socio-political and economic challenges. |
| GOI, 2011; Thorat & Ahmad, 2015; Thorat, 2022 | The minority population (Muslims, Sikhs, Christians, Buddhists, Jains and Parsis), constitutes about 20% of the total population of the country. |
| Narula, 2014; Noor, 2016; Terziev, 2022; Panakaje, 2022 | Education plays a vital role in the all-round development of an individual as well as a group of individuals of minorities. |

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| Khan and Butool, 2013; Mir, & Pramanik, 2017; Malik, 2023; Midya, & Islam, 2024 | Necessity to improve minorities participation in higher education, specially engineering, where they are extremely underrepresented. |
| Gupta, & Dewanga, 2012; Tilak, 2020 | Technical education has a direct impact on employment & earnings of individuals. |
| Narula, 2014; Shariff, 2023; Kim, 2023; | Necessity of targeted policies for underrepresentation of minorities in higher education |
| Sönmez, & Yenmez, 2019; Chakrabarty, 2022; Veeresha, 2022; Sardoč, 2022; Babu, *et.al*, 2022 | Concerns about challenges in defining criteria for reservations, and implications of merit-based selection. |
| Noor, 2016; Dar, et.al, 2022; Saif, & Kumar, 2023 | Educationally empowered communities efficiently take part in the development process. |
| Shazli and Asma 2015; Ur Rehman, et.al., 2020; Malik, 2023 | Minorities often face many challenges related to socio-economic, religious and gender factors, and experience a distinct form of social deprivation, resulting to significant backwardness. |
| Iqbal, 2012; Khan and Butool, 2013; Mir, & Pramanik, 2017; Hussain *et al.*, 2018; Mollah, & Bera, 2018; Joshi and Ahir, 2019; Holthaus, 2023 | Literacy rate of Muslims is only 57.3%, where 62.41% of males and 51.90% of females are literate, which is least in all minorities. Highest literacy rate found among Jains, followed by Christians, Buddhists and Sikhs. |
| Singh, 2012; Khan and Butool, 2013; Khan, 2015 | Representation of students from minorities, especially Muslims and Muslim females, is significantly low. |
| Joshi and Ahir, 2019; Tilak and Choudhury, 2021 | Minimizing socioeconomic inequalities is considered as the prime engine of the upward progress of marginalized communities. |
| Fortenberry, 1994; Huang,2000; Ali and Bagheri, 2009; Singh,2012; Kargarmoakhar and Ross, 2019 | Several efforts been made to attract minority students to engineering disciplines and increase their participation in this field. |
| Ionescu and Cuza,2012 | Higher the level of education, better the chances of getting a job. Engineering education can increase the likelihood of engaging in employment. |
| Khan and Butool, 2013 | Participation rates of women in higher education are higher among all other communities compared to Muslims, highest in Jains. |
| Bevelander and Otterbeck, 2010; Basant,2012; Saleem,2021 | High drop-out rates after middle school among Muslims constitutes lower participation in higher education. |
| Allarahamali *et al.*, 2022; Abidi, 2022 | Universally believed that if women remain deprived of education, our society will not be able to develop completely. |

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| Jaina be, 2017; Sengupta & Rooj 2018; Abidi & Kazmi, 2019 | Islamic society doesn't permit girls to be treated like boys for pursuing higher education. |
| Rekha, 2006; Oplatka and Lapidot, 2012; Kargarmoakhar and Ross, 2019 | Drop-out percentage of Muslim girls at the primary level education is less than that of boys, but it increases in higher education. Muslim girls have very little access to engineering and technical education especially. |
| Barbhuyan, & Goswami, 2015; Abidi, 2022 | Socio-cultural set-up and patriarchal mindsets of our society, which prioritize men over women impacts women education. |
| Hussain, *et al.*, 2018; Kapur,2019; Haider, 2021 | Lack of awareness and connection between madrasa education and modern education and insecurity of girls causes low participation of Muslim women in higher education. |
| Irum *et al.*, 2015; Ashraf and Kumar 2019 | Primary difficulty in women's higher education is men's dominance in society. Also, personal difficulties met by girls makes it difficult to be present in the college during menstrual periods. |
| Powell *et al*., 2009; Bock *et al*., 2013; Riegle-Crumb and Moor, 2013; Ahmad, 2014; Merayo, & Ayuso, 2023 | Lower academic support, negative attitude of parents & teachers towards girl's engineering carrier, and girls' willingness to have separate institutions are the key reasons of low enrolment of girls in science and engineering stream. |
| Becerra, et. al., 2023; Tzafea, 2023). | Study reports poor academic performance of students from minority groups in higher education. |
| Kotay,2013; Maduwanthi, et.al., 2016; Sabharwal, 2021; Malik, 2023 | Muslims face a double disadvantage: lower levels of education compared to others, and lower academic performance in higher education also. |
| Dash and Bosel,2020; Farca, & Gheorghe, 2023 | Poor academic performance directly harms employment and earnings of minority students in engineering field. |
| Paul and Das; 2020; Govindarajoo, et.al., 2022; Gutiérrez-de-Rozas, et.al., 2022; Selvarajoo, & Baharudin, 2023 | Problems like more syllabus, selection of wrong subject for study, distance education institutes, absence of proper guidance etc, affects academic performance of students. |
| Oplatka and Lapidot, 2012; Hussain, *et al.*, 2018; Kapur,2019; García-Vita, M. D. M., Medina-García, et.al., 2021 | Studies have emphasized the impact of socio-cultural factors on the academic achievement of minority students. Need of targeted interventions for specific challenges faced by minority students. |
| Khan and Butool, 2013; Alam *et al.*, 2014 | Some minorities, like Jains and Christians achieve remarkable academic success despite various obstacles. |
| Ali., 2021; Ali., et.al., 2022; Nazari, 2022; Alesina, et. al., 2023 | Emphasize on the inequalities faced by Muslims compared to other groups in education as well as job market. |
| Carreira, & Lopes, 2017; Wicht, et.al., 2019; Etim, 2023 | Academic performance along with knowledge and skills improves position in labour market. |

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| Kotay,2013; Balasubramanian, 2020 | Muslim students show lower educational performance and competency compared to other groups. |
| Stevenson, et.al., 2017; Tariq, & Syed, 2018; Srivastava, 2019; Linando, 2024 | Prejudice based on their religion, and negative stereotypes about minority groups affect their hiring. |
| Stevenson, et.al., 2017; Choirudin, et.al., 2022 | Limited financial resources hinder them from pursuing necessary training for career advancement. |
| Holladay, et.al., 2023; Abulbasal, et.al., 2023; Dalessandro, & Lovell, 2023; Rahim-Dillard, & Johnson, 2023 | Limited representation of minority individuals in leadership positions perpetuates inequalities in the workplace. |
| Pager & Shepherd, 2008; Froy & Pyne, 2011; Sanders, & Orbe, 2017; Wang, & Mo, 2018, Gorman, & Kay, 2020 | Need for targeted initiatives to enhance the professional/career advancement and personal development of minority students. |
| Robinson, 2016; Alesina, et.al., 2023; Bhattacharjee, & Roy Chaudhuri, 2023 | Muslim students earning significantly less than students from other religious groups. |
| Geetha Rani, 2014; Watts, 2020; Kushwaha, 2023 | Lower academic performances of Muslim students result in lower earnings. |
| Rani, 2013; Stevenson, et.al., 2017; Sabharwal, 2021 | Socio-economic and Cultural factors influence the earnings of minority students. Moreover, factors such as language of instruction and workplace communication skills influence their financial success in the workplace. |
| Kumar, & Hashmi, 2020; Forth, et.al., 2023 | Workplace discrimination and limited career advancement opportunities shapes the earnings gap. |
| Dash and Bosel,2020 | Lack of advanced training, and practical experiences during studies, influences employability and earning potential. |
| Ahmed, 2015; Khattab, 2016; Saleh, 2019; Dubey et al, 2019; Nazari, 2022; Noorjahan, 2023 | Emphasizes the importance of ongoing efforts to promote equity in higher education, including in fields such as engineering. |
| Razak, et.al.,2021; Etim, 2023 | Minority students often face disparities in educational resources and limited access to professional networks and mentors. |

## 2.4 Women in Engineering Education

Women education is considered one of the pivotal factors for social, political, cultural and economic development of the society. If women are deprived and neglected of education in any

society, then the future will not be optimistic (Sharma, 2016; Siddique, et.al., 2021; Yadav, 2022). Despite achieving near-universal primary school attendance and bridging the gender gap in India, disparities persist in the share of women in education compared to men. Studies reveal that girls lag behind in enrolment in high-end technical institutes, and professional courses (Singh, N. 2007; Yadav, & Singh, 2020; Rashmi, et.al., 2022). Historically, women in India face numerous barriers to accessing quality education. Gender disparities in educational participation can be primarily attributed to socio-cultural norms, economic constraints, inadequate infrastructure, parental behaviour, and gender biases in education system (Kakkar, 2020; Asadullah, & Yeasmin, 2022; Noorjahan, 2023). In fact, gender discrimination seems to be a very serious and condemnable reality in India as it is present in every sector including education as well as employment and earning (Jha and Nagar, 2015). In particular, women have much lower participation rates than men in higher education, including fields such as engineering and technology (Gupta,2012; Melak and Singh,2021). Additionally, their interests in the labour market, such as employment preferences and salary expectations, are lower than those of men (Taylor,2007; Das *et al.*, 2015).

The issue of under-representation of women in higher education, especially engineering, has been a matter of great concern (Dasgupta & Stout, 2014; Patterson et al., 2021; Tilak and Choudhury, 2021). As women's participation in University education is not only an important aspect in development of the country; it is a crucial element in the process of improving the quality of life of women themselves because it has a direct effect on women's productivity and earnings as well (Morley, 2006). Lack of access to higher education negatively affects women's employment and career opportunities, which can be detrimental to their overall socioeconomic advancement (Kasi, et.al., 2021; BalaKoteswari, 2022). The representation of women in engineering education in India is comparatively very low, but it has been gradually increasing in recent years (Gupta,2012). Several efforts have been made to increase the participation of women in the fields of STEM (Science, Technology, Engineering, and Mathematics), but these processes are influencing at a very slow pace (Ramirez and Wotipka,2001; Singh & Singh, 2018). The share of women in STEM education is still lower than that of men, especially in engineering and technology. Engineering education is largely considered a male-dominated profession in the country, and not many women are found in the field (Eardley and Manvell, 2006; Silbey,2016; Swarup and Dey, 2020; Patterson et al., 2021). Given that women constitute almost half of the Indian society, there is a need to improve their participation in higher

education, especially in the field of engineering (Henriksen, et.al., 2014; Gaikwad, & Pandey, 2022).

Some researchers have revealed that women express less interest and confidence in the engineering field than men, while engineering remains a popular subject of study for both men and women alike. At the same time, the image of engineering as a male profession creates the perception that it is not a profession suitable for women, which is perhaps why women are less interested in the field. This is one of the main reasons for gender disparity in engineering education (Powell *et al*., 2009; Riegle-Crumb and Moor,2013). On the other hand, women who are interested in pursuing a career in engineering encounter many distinct types of problems compared to men for entering this field. Therefore, they choose slightly different subjects during their college education, and are less likely to join the engineering field (Chopra *et al.,* 2019). Studies have been conducted to examine the factors contributing to this gender disparity and the challenges faced by women who wish to pursue engineering education. These challenges can be summarized as follows: low socioeconomic status of parents, narrow socio-cultural and psychological landscape of the society, scepticism of parents about girls pursuing engineering career, and other related factors contribute to the low participation of women in engineering education (Balakrishnan & Low, 2016; Olson, K. 2019; Ahmed et al., 2022).

Some of the key factors identified are socio-cultural norms, widespread stereotypes, limited access to resources, and lack of female role models, all of which influence gender inequality in engineering education (Malkogeorgou, & Duffy, 2022; Chan, 2022; Silva, et.al.,2023). Socio-cultural norms play an important role in shaping perceptions of gender roles, often discouraging women from pursuing careers in engineering (Dasgupta & Stout, 2014). Prevailing stereotypes associating engineering with masculinity further reinforce the perception that engineering is not a suitable career choice for women (Hardtke, et al., 2022; Blosser, 2024). Additionally, women face limited access to educational resources and opportunities, including a lack of guidance and support networks (Mamo *et al.*,2017). The lack of visible female role models in engineering further exacerbates this issue, as aspiring women struggle to find relatable figures who have successfully navigated the engineering career path. Hence, females tend to report lower levels of interest and express diminished confidence in comparison to their male counterparts within the field of engineering (Banker, D. V., & Banker, K. 2017, Stewart, C.A., 2021; Amirtham, & Kumar, 2023). Such difficulties reduce girls' motivation and discourage them to pursuing careers in engineering, resulting in their low participation in engineering education.

Researchers have also revealed the challenges women face after entering engineering education and the factors contributing to the inequalities they experience. In many developing countries, including India, females tend to achieve lower educational outcomes compared to males in higher education (Mamo et al., 2017; Lisiswanti, 2022). Several factors can be attributed to gender disparities in academic performance of students, especially in the field of engineering education. Primarily, women face more external obstacles to success in this field compared to men. Socio-cultural and economic influences, parents' education and occupation, university-related factors, and campus environment majorly affect the academic performance of female students in higher education including engineering (Tiruneh and Petros, 2014; Raja, et.al., 2021). Problems related to educational approaches, such as lack of suitable occupational courses, selection of wrong subjects for study, distance education institutions, and absence of proper guidance, are also barriers for female students in performing well in engineering education (Paul and Das; 2020; Govindarajoo, et.al., 2022). Moreover, females often exhibit less confidence than males in various aspects such as general intelligence, problem-solving, spatial abilities, science, mathematics, computer knowledge, writing, and interpersonal communication skills, as well as using tools or machines. As a result, females have less academic self-assurance than males (Schreuders et al., 2009; Shi, 2018).

Thus, several investigations have explored the academic performance of women, highlighting the barriers they face in higher education, including engineering. Despite various challenges, studies also show that women achieve admirable academic success in higher education fields such as humanities, social sciences, health care education (including nursing and medicine), and life sciences. In these fields often have higher female enrolment and academic achievement rates compared to traditionally male-dominated fields like engineering and technology (Swarup and Dey, 2020; Kim, et.al., 2022; Angwaomaodoko, 2023). For instance, a study by Melak and Singh (2021) found that female students, particularly in the field of engineering, face gender-based biases, and demonstrate lower academic performance than their male counterparts. Socio-economic factors have been a focal point in understanding women's educational attainment in engineering, with studies also emphasizing the need for targeted interventions to address the specific barriers faced by female students (Mamo et al., 2017; Shi, 2018).

Studies have examined the career paths of female engineering students, who face a number of challenges in securing employment and advancing in their profession. There are gender disparities in employment preferences and salary expectations in the engineering field. Women face discrimination in job opportunities and earnings in this field, and the gender difference in

earnings is much more pronounced than the difference in job prospects, which limits their expectations (Taylor,2007; Livanos *et al.*, 2009; Choudhury, 2015; Lama, & Majumder, 2018). Observations of work experience and occupational characteristics of both men and women in the engineering labour market indicate that the gender difference in placement is around 60%, and the difference in salary is approximately two-thirds (Graham and Smith,2005). According to the study conducted by Choudhury, (2015), only a few percentages of females get employed compared to males, and the earning of women are about 54% less than that of men in engineering. The study also found that a number of socioeconomic factors, prior academic experiences, and institutional management (government/private) had a significant impact on students' employment and earnings. Furthermore, women often experience a less favourable work environment in the workplace than their male colleagues (Hosaka, 2014).

Thus, researchers have shown that in the engineering field, female students' employment rates lag behind those of their male counterparts, and their earnings are also lower than those of males. A number of factors can be attributed to gender disparities in employment and earnings among engineering students, such as cultural barriers, social attitudes, stereotypes and biases, family responsibilities, limited access to educational resources, inadequate training or skills, workplace policies and practices, a lack of negotiating skills for higher salaries and benefits, and the prevalence of harassment and discrimination in the workplace (Graham and Smith,2005; Livanos *et al.*, 2009; Li and Miller,2012; Zhang *et al.*,2021). Females' educational attainment is lower than that of males in most developing countries, including India, whereas students' position in the labour market is influenced by their academic performance. Indeed, employers give top priority to students' academic achievements during the recruitment process as it helps determine their placement and salary in the labour market. It may also contribute to discrimination against women in the job market because males typically outperform females in terms of academic performance and competency (Mamo *et al.*,2017; Bartolj, & Polanec, 2021; Di Paolo, & Matano, 2022; McCann, & Hewitt, 2023). Proper Mentorship has also emerged as a crucial factor in helping women navigate the challenges of the job market and establish a position in the engineering profession (Lopez, & Duran, 2021; Konyeha, et.al., 2021; Barkhuizen, et.al., 2022). Gender disparities in the labour market in India are a distinct phenomenon and regarded as a major area of policy concern. However, studies highlight the importance of promoting equal opportunities in the engineering labour market, and addressing systemic barriers to women's placement, earning, career advancement, and workplace satisfaction (Tangnu, & Sharma, 2012; Imasogie, et.al., 2018; Gaikwad, & Pandey, 2022).

Turning specifically to the earnings of women in engineering, research has explained the disparities in economic outcomes experienced by female engineers. Studies have highlighted the differences in earnings among women engineers and have advocated for interventions to address these disparities (Graham and Smith,2005; Taylor,2007; Lama, & Majumder, 2018). Potentially, women can advance in their careers through employment opportunities, but as a result, they are forced into lower-paying positions where they must settle for a low salary. Stereotypes in the media, society, and family can have an impact on women's decisions to take low-paying jobs, as can some traditional roles that place women in low-paying positions. Women represent roles of wife and mother in countries, like Bangladesh, Kenya, China, and India, and they leave work early due to family obligations; as a result, women work less than men and are reluctant to relocate, even when it is necessary (Moinifar, 2012; Chatterjee, 2016). Moreover, studies have found that although academic performance significantly influences earnings, workplace discrimination and limited career opportunities are also crucial factors contributing to earnings differentials (Tangnu, & Sharma, 2012; Lama, & Majumder, 2018; Tentama & Abdillah, 2019; Gaikwad, & Pandey, 2022). Persistent disparities in earnings for women in engineering emphasize the continued necessity for efforts aimed at promoting equity in the profession.

**Table-2.3: Brief literature on Women in Engineering Education**

| Authors/Years | Findings |
|---|---|
| Sharma, 2016; Siddique, et.al., 2021; Yadav, 2022 | Women's future depends on education which depends on social, political, cultural and economic development of the society |
| Singh, N. 2007; Yadav, & Singh, 2020; Rashmi, et.al., 2022 | Girls lag in enrolling to high-end technical institutes, and professional courses. |
| Kakkar, 2020; Asadullah, & Yeasmin, 2022; Noorjahan, 2023 | Various gender disparities in educational participation create biases in the education system. |
| Jha and Nagar, 2015 | Gender discrimination presents in every sector including education as well as employment and earning |
| Gupta,2012; Melak and Singh,2021 | Women's participation rates are much lower than men in engineering and technology. |
| Taylor,2007; Das *et al.*, 2015 | Women's employment preferences and salary expectations are lower than men. |
| Morley, 2006 | University education has a direct effect on women's productivity and earnings as well |

| | |
|---|---|
| Kasi, et.al., 2021; BalaKoteswari, 2022 | Lack of access to higher education can be detrimental to women's advancements in employment and career opportunities. |
| Gupta,2012 | Women representation in engineering is gradually increasing in recent years. |
| Ramirez and Wotipka,2001; Singh & Singh, 2018 | Several efforts made to increase women participation in the fields of STEM, but its influencing at a very slow pace. |
| Eardley and Manvell, 2006; Powell *et al.*, 2009; Riegle-Crumb and Moor,2013 Silbey,2016; Swarup and Dey, 2020; Patterson et al., 2021 | Engineering is considered a male-dominated profession, and not many women are found in the field. |
| Henriksen, et.al., 2014; Gaikwad, & Pandey, 2022 | Women constitute half of the Indian society, still we need to improve their participation in higher education. |
| Chopra *et al.*, 2019 | Women who are interested in pursuing engineering encounter distinct type of problems, so, they choose slightly different subjects during college education, less likely to join the engineering field. |
| Balakrishnan & Low, 2016; Olson, K. 2019; Ahmed et al., 2022 | Low participation of women in engineering is a result of narrow socio-cultural and psychological landscape of the society. |
| Dasgupta & Stout, 2014; Malkogeorgou, & Duffy, 2022; Chan, 2022; Silva, et.al.,2023 | Key factors are socio-cultural norms, stereotypes, limited access to resources, that influence gender inequality in engineering education |
| Hardtke, et al., 2022; Blosser, 2024 | Stereotypes associate engineering with masculinity, precepting engineering is not a suitable career choice for women. |
| Banker, D. V., & Banker, K. 2017, Mamo et al., 2017; Stewart, C.A., 2021; Lisiswanti, 2022; Amirtham, & Kumar, 2023 | Females show lower levels of confidence and outcomes in comparison to men for engineering because of lack of visible female role models in engineering. |
| Tiruneh and Petros, 2014; Raja, et.al., 2021 | Socio-cultural and economic influences, parents' education and occupation, university-related factors, and campus environment majorly affect the academic performance of female students in higher education. |
| Paul and Das; 2020; Govindarajoo, et.al., 2022 | Wrong educational approaches and absence of proper guidance are also barriers for female students in performing well in engineering. |
| Schreuders et al., 2009; Shi, 2018 | Females have less academic self-assurance than males. |
| Swarup and Dey, 2020; Kim, et.al., 2022; Angwaomaodoko, 2023 | Women show admirable academic success in humanities or healthcare in comparison to engineering. |
| Mamo et al., 2017; Shi, 2018 | Need for targeted interventions to address the specific barriers faced by female students. |

| | |
|---|---|
| Taylor,2007; Livanos *et al.*, 2009; Choudhury, 2015; Lama, & Majumder, 2018 | Women face discrimination in job opportunities and earnings in this field. Only a few percentages of females get employed compared to males, and the earning of women are about 54% less than that of men in engineering. |
| Graham and Smith,2005 | Reports show gender difference in placement is around 60%, and difference in salary is approximately two-thirds. |
| Hosaka, 2014 | Women often experience a less favourable work environment in the workplace than their male colleagues |
| Graham and Smith,2005; Livanos *et al.*, 2009; Li and Miller,2012; Zhang *et al.*,2021 | Factors attributed to gender disparities in employment and earnings includes social and cultural barriers, stereotypes and biases, family responsibilities, limited access to educational resources, inadequate training or skills, and the prevalence of harassment and discrimination in the workplace. |
| Mamo *et al.*,2017; Bartolj, & Polanec, 2021; Di Paolo, & Matano, 2022; McCann, & Hewitt, 2023 | As males typically outperform females in terms of academic performance and competency, women lack opportunity in labour market also. |
| Lopez, & Duran, 2021; Konyeha, et.al., 2021; Barkhuizen, et.al., 2022 | Proper Mentorship is a crucial factor in helping women navigate the challenges of the job market. |
| Tangnu, & Sharma, 2012; Imasogie, et.al., 2018; Gaikwad, & Pandey, 2022 | Promoting equal opportunities in the engineering labour market, and addressing systemic barriers to women's placement and workplace satisfaction is important. |
| Graham and Smith,2005; Taylor,2007; Lama, & Majumder, 2018 | Studies highlight the differences in earnings among women engineers and need for interventions to address these disparities. |
| Moinifar, 2012; Chatterjee, 2016 | Due to multiple responsibilities, women in India, leave work early or are reluctant to relocate, even when it is necessary. |
| Tangnu, & Sharma, 2012; Lama, & Majumder, 2018; Tentama & Abdillah, 2019; Gaikwad, & Pandey, 2022 | Other than academic performance, workplace discrimination and limited career opportunities are also crucial factors contributing to earnings differentials in women. |

## 2.5 Research Gap

The extensive review of available literature clearly shows that there is paucity of research on status of students enrolled through reservation and other affirmative action. The gap in the existing literature may be discussed as below:

**2.5.1** There is hardly any work on marginalised groups who are admitted in engineering education through reservation or other affirmative programme in Delhi during last decade.

**2.5.2** Though all engineering institutions in Delhi adopts one or other affirmative programme for enrolment of students from marginalised groups. However, has rarely been researched of all institutions at one place.

**2.5.3** The issue of reservation has always been discussed among scholars. However. Hardly any work investigates socio-demographic and economic status of the students who are admitted in engineering institutions through reservation or establishment of institution for religious minorities.

**2.5.4** We have seen in the review that SC, ST and OBC students prefer general education but has not been investigated properly about their academic performance, employment and earnings.

**2.5.5** Though there are some work on Muslims but rarely any one has considered all minorities simultaneously in their research on academic performance, employment and earnings of these students.

**2.5.6** Gender has always remained very significant issue in development literature. Their participation in higher education are considered an important indicator for their empowerment. However, even in higher education, they tend to achieve lower educational outcomes. Even their earnings are lower when compared with their male counterparts. It is utmost important to investigate that whether same trend is happening in engineering education i.e. their academic achievement, employment and earning. Specially among those who belong to marginalised groups.

## 2.6. To Sum up the Chapter

To sum up, on the basis of available literature, it can be said that participating of students from marginalised groups as SC, ST and OBC as well as religious minorities is far below the satisfactory level but much more serious work needs to be done for clear understanding of their

situation. The existing research gap has been discussed in this chapter which will be further investigated in the following chapters. The objectives of this research (given in chapter- 3) has been derived from the research gap listed in the previous section (2.5) of Chapter-2. The objectives have been analysed using descriptive statistics (chapter-4) and inferential statistics (chapter-5).

# CHAPTER – 3

# RESEARCH METHODOLOGY

## 3.1. Background

As discussed in the chapter-2, reservation stands as the most often used affirmative action in education in India. Various types of reservation policies in enrolment have been adopted for different student groups at different levels. Additionally, the Constitution of India allows religious minority groups to establish educational institutions for their betterment in education. However, there has been a notable dearth of studies investigating the beneficiaries of such reservation policies within the reserved category and the subsequent outcomes once they enrol in education, especially in the context of engineering education. This study aims to bridge the gap by investigating the status of three student groups, namely Scheduled Caste (SC), Scheduled Tribe (ST), and Other Backward Classes (OBC) students, along with students belonging to religious Minority groups, who benefit from affirmative measures such as reservation policies in enrolment, and the establishment of educational institutions. Further, the study exploring the differences between male and female students within these groups. By exploring into these aspects, the research sheds light on the academic performance, employment and earning of such students in engineering education in Delhi.

## 3.2. Objectives, Hypothesis, and Research Methodology of the study

On the basis of earlier discussed research gaps, there are five objectives of the study. In this section, the objectives, hypotheses arising from the objectives, and the research methods applied have been discussed.

**Objective-1:** To discuss all affirmative programmes offered by degree level engineering institutions in Delhi.

**Research Method:** Qualitative analysis (Discussed in Chapter-4)

**Objective-2:** To investigate the socio-demographic and economic status of the following:

**2.1:** Scheduled Caste (SC), Scheduled Tribe (ST), and Other Backward Classes (OBC)

**2.2:** Religious Minorities.

**2.3:** Male and Female

**Research Method:** Descriptive statistics based on percentage share have been calculated for all groups separately (Discussed in Chapter 4).

**Objective-3:** To analyse and compare the academic performance, placement and earnings among SC, ST and OBC engineering students.

**Hypothesis:**

$H_{10}$ = Management of the Institution, Gender, Caste, Fath_Edu., Moth_Edu., Fath_Occu., Moth_Occu., FA_Income, Scholarship, Accommodation, Senior_Sec-Per, Senior_Sec_Med, independent variables taken in the analysis of academic performances of SC, ST and OBC students are not significantly affecting the dependent variable "CGPA_of _Grad.". $\beta i \neq 0$ [ where $\beta i$= 1,2,3,4,5,6,7,8,9,10,11,12]

$H_{11}$ = Managemen of the institution, Gender, Caste, Fath_Edu., Moth_Edu., Fath_Occu., Moth_Occu., FA_Income, Scholarship, Accommodation, Senior_Sec-Per, Senior_Sec_Med, independent variables taken in the analysis of academic performances of SC, ST and OBC students are significantly affecting the dependent variable "CGPA_of _Grad.". $\beta i \neq 0$ [ where $\beta i$= 1,2,3,4,5,6,7,8,9,10,11,12]

$H_{20}$ = There is no significant difference in the academic performance between OBC and SC, ST engineering students.

$H_{21}$ = There is a significant difference in the academic performance between OBC and SC, ST engineering students.

$H_{30}$ = Management of the institution, Gender, Caste, Senior_Sec_Per, Senior_Sec_Med, CGPA_ of _Grad., independent variables taken in the analysis of placement of SC, ST and OBC students are not significantly affecting the dependent variable "Placement" of engineering students. $\beta i \neq 0$ [ where $\beta i$= 1,2,3,4,5,6]

$H_{31}$ = Management of the institution, Gender, Caste, Senior_Sec_Per, Senior_Sec_Med, CGPA_ of _Grad., independent variables taken in the analysis of placement of SC, ST and OBC students are significantly affecting the dependent variable "Placement" of engineering students. $\beta i \neq 0$ [ where $\beta i = 1,2,3,4,5,6$]

$H_{40}$ = There is no significant difference in the placement between OBC and SC, ST engineering students.

$H_{41}$ = There is a significant difference in the placement between OBC and SC, ST engineering students.

$H_{50}$ = Management of the institution, Gender, Caste, CGPA_ of _Grad., independent variables taken in the analysis of earnings of SC, ST and OBC students are not significantly affecting the dependent variable "annual earnings" of engineering students, $\beta i \neq 0$ [where $\beta i = 1,2,3,4$]

$H_{51}$ = Management of the institution, Gender, Caste, CGPA_ of _Grad., independent variables taken in the analysis of earnings of SC, ST and OBC students are significantly affecting the dependent variable "annual earnings" of engineering students, $\beta i \neq 0$ [where $\beta i = 1,2,3,4$]

$H_{60}$ = There is no significant difference in the earning between OBC and SC, ST engineering students.

$H_{61}$ = There is a significant difference in the earnings between OBC and SC, ST engineering students.

**Research Methods:** Inferential Statistics; The Ordinary Least Squares (OLS) method has been used to analyse and compare the academic performance, while the Heckman selection model was used to analyse and compare the placement and earnings among SC, ST and OBC students. In the analysis and comparison of academic performance, placement and earnings, three separate equations were estimated for each section of the analysis one for SC and ST students, one for OBC students, and one for overall (Discussed in Chapter-5).

**Objective-4:** To analyse and compare the academic performance, placement and earnings among religious minority students in engineering education.

**Hypothesis:**

$H_{70}$ = Management of the institution, Gender, Religion, Fath_Edu., Moth_Edu., Fath_Occu., Moth_Occu., FA_Income, Senior_Sec-Per, Senior_Sec_Med, independent variables taken in the analysis of academic performances of minority students are not significantly affecting the dependent variable "CGPA_of_Grad.". $\beta i \neq 0$ [ where $\beta i$= 1,2,3,4,5,6,7,8,9,10].

$H_{71}$ = Management of the institution, Gender, Religion, Fath_Edu., Moth_Edu., Fath_Occu., Moth_Occu., FA_Income, Senior_Sec-Per, Senior_Sec_Med, independent variables taken in the analysis of academic performances of minority students are significantly affecting the dependent variable "CGPA_of_Grad.". $\beta i \neq 0$ [ where $\beta i$= 1,2,3,4,5,6,7,8,9,10].

$H_{80}$ = There is no significant difference in the academic performance among Muslims and other minority engineering students.

$H_{81}$ = There is a significant difference in the academic performance among Muslims and other minority engineering students.

$H_{90}$ = Management of the institution, Gender, Religion, Senior_Sec_Per, Senior_Sec_Med, CGPA_of_Grad., independent variables taken in the analysis of "placement" of minority students are not significantly affecting the dependent variable "placement" of engineering students, $\beta i \neq 0$ [ where $\beta i$=1,2,3,4,5,6].

$H_{91}$ = Management of the institution, Gender, Religion, Senior_Sec_Per, Senior_Sec_Med, CGPA_ of _Grad., independent variables taken in the analysis of "placement" of minority students are significantly affecting the dependent variable "placement" of engineering students, $\beta i \neq 0$ [where $\beta i$=1,2,3,4,5,6].

$H_{100}$ = There is no significant difference in the placement among Muslims and other Minorities.

$H_{101}$ = There is a significant difference in the placement among Muslims, and other Minorities.

$H_{110}$ = Management of the institution, Gender, Religion, CGPA_ of _Grad., independent variables taken in the analysis of earnings of minority students are not significantly affecting the dependent variable "annual earnings" of students. $\beta i \neq 0$ [ where $\beta i = 1,2,3,4$].

$H_{111}$ = Management of the institution, Gender, Religion, CGPA_ of _Grad., independent variables taken in the analysis of earnings of minority students are significantly affecting the dependent variable "annual earning" of students. $\beta i \neq 0$ [ where $\beta i = 1,2,3,4$].

$H_{120}$ = There is no significant difference in the earnings between Muslims and other minority students.

$H_{121}$ = There is a significant difference in the earnings between Muslims and other minority students.

**Research Methods:** Inferential Statistics; The Ordinary Least Squares (OLS) method has been used to analyse and compare the academic performance, while the Heckman selection model was used to analyse and compare the placement and earnings among religious minority students. In the analysis and comparison of academic performance, placement and earnings, three separate equations were estimated for each section of the analysis one for Muslims, one for other minorities, and one for overall (Discussed in Chapter-5).

**Objective-5:** To analyse and compare the academic performance, placement and earnings of female engineering students with their male counterparts.

**Hypothesis:**

$H_{130}$ = Management of the institution, Gender, Religion, Caste, Fath_Edu., Moth_Edu., Fath_Occu., Moth_Occu., FA_Income, Senior_Sec-Per, Senior_Sec-Sch_Type, Senior_Sec_Med, Independent variables taken in the analysis of academic performances of male and female students are not significantly affecting the

dependent variable “CGPA_of_Grad.”, βi≠ 0 [ where βi= 1,2,3,4,5,6,7,8,9,10,11,12].

$H_{131}$ = Management of the institution, Gender, Religion, Caste, Fath_Edu., Moth_Edu., Fath_Occu. Moth_Occu., FA_Income, Senior_Sec-Per, Senior_Sec-Sch_Type, Senior_Sec_Med, independent variables taken in the analysis of academic performances of male and female students are significantly affecting the dependent variable “CGPA_of_Grad.”, βi≠ 0 [ where βi= 1,2,3,4,5,6,7,8,9,10,11,12].

$H_{140}$= There is no significant difference in the academic performance between male and female engineering students.

$H_{141}$ = There is a significant difference in the academic performance between male and female engineering students.

$H_{150}$ = Management of the institution, Gender, Religion, Caste, Senior_Sec_Per, Senior_Sec_Med, CGPA_ of _Grad., independent variables taken in the analysis of placement of male and females are not significantly affecting the dependent variable “placement” of engineering students, βi≠ 0 [ where βi= 1,2,3,4,5,6,7].

$H_{151}$ = Management of the institution, Gender, Religion, Caste, Senior_Sec_Per, Senior_Sec_Med, CGPA_ of _Grad., independent variables taken in the analysis of placement of male and female students are significantly affecting the dependent variable “placement” of engineering students, βi≠ 0[ where βi= 1,2,3,4,5,6,7].

$H_{160}$ = There is no significant difference in the placement between male and female engineering students.

$H_{161}$ = There is a significant difference in the placement between male and female engineering students.

$H_{170}$ = Management of the institution, Gender, Religion, Caste, CGPA_ of _Grad., independent variables taken in the analysis of earnings of male and female students are not significantly affecting the dependent variable “annual earnings” of students, βi≠ 0 [ where βi= 1,2,3,4,5].

$H_{171}$ = Management of the institution, Gender, Religion, Caste, CGPA_ of _Grad., independent variables taken in the analysis of earnings of male and female students are significantly affecting the dependent variable "annual earnings" of students $\beta i \neq 0$ [ where $\beta i = 1,2,3,4,5$].

$H_{180}$ = There is no significant difference in the earning between male and female engineering students.

$H_{181}$ = There is a significant difference in the earnings between male and female engineering students.

**Research Methods:** Inferential Statistics; The Ordinary Least Squares (OLS) method has been used to analyse and compare the academic performance, while the Heckman selection model was used to analyse and compare the placement and earnings between male and female students. In the analysis and comparison of academic performance, placement and earnings, three separate equations were estimated for each section of the analysis one for male, one for female, and one for overall (Discussed in Chapter-5).

## 3.3. Data Used in the Study

The study is based on primary data obtained through a survey conducted in all degree level engineering institutions in Delhi. The primary survey was done during the academic year 2018-19, particularly targeted on the students enrolled for B-Tech programme in engineering institutions in the academic year 2015-16, and graduated in 2019.

The data collection process involving multiple visits to each institution. During the initial visits, discussions were held with university/institution teachers to outline the data requirements and categorize eligible students for the study. Subsequent visits were scheduled based on the availability of teachers and students. Questionnaires were distributed during class sessions, with efforts made to ensure maximum participation. However, data collection faced challenges, including student absenteeism and some students opting out of the survey. Additional visits were made to collect data from absent students and gather institutional information. In some cases, scheduling conflicts with the head of the institution necessitated rescheduling for a later date. Despite concerted efforts, only 18 institutions out of 20 engineering institutions in Delhi

responded to the survey, while two private institutions opting out of the survey and were therefore excluded from the study.

Thus, only primary data has been used for the study. It was collected through two open-ended structured questionnaires i.e. Institutional Questionnaire and Student Questionnaire. Details regarding both are discussed below:

### 3.3.1. Institutional Questionnaire

The first type of questionnaire was designed to gather information from all engineering institutions in Delhi. The Institutional questionnaire was filled by the Head (principal/director or their representative) of each institution. It covered various aspects of data, which are shown in Table-3.1.

The questionnaire covers institutional, academic, governance policies, and all other affirmative measures of the institutions/university. It includes questions related to enrolled students categorized by gender and social category. The academic section of the questionnaire also collects data on the number of applicants for different courses during the academic year under study (2015-2016).

**Table -3.1: Data Covered by the Institutional Questionnaire**

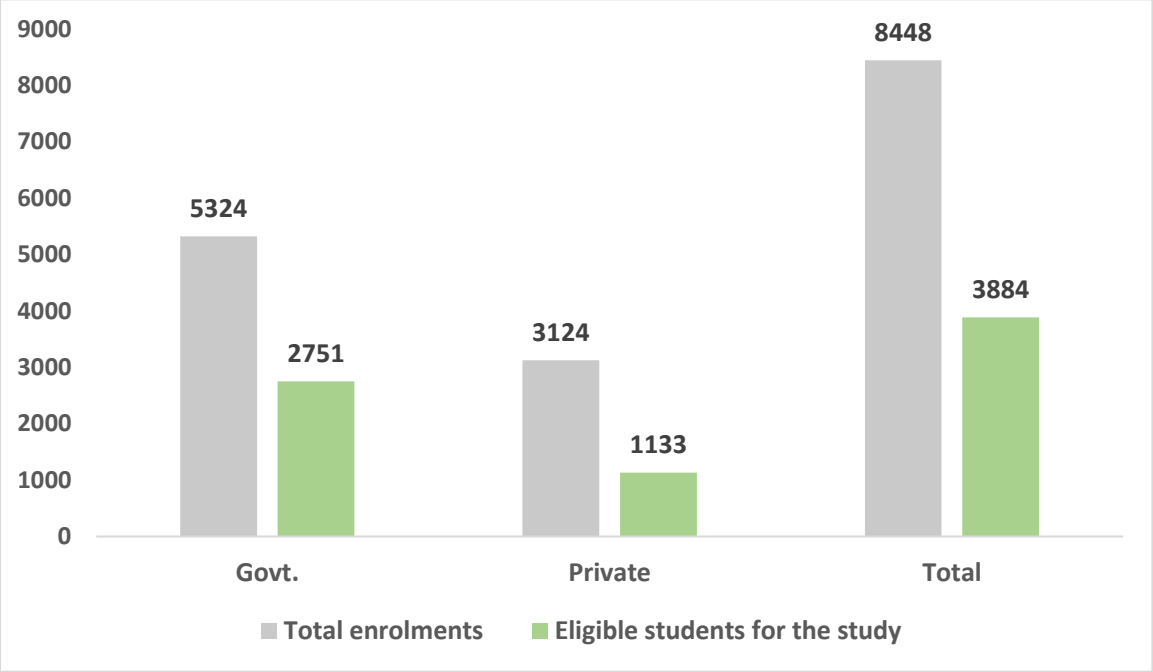
| S. N | Data covered | |
|---|---|---|
| **1.** | Management of the Institutions | |
| **2.** | Reservation Policies in enrolment, and other affirmative programmes for students in the institutions | |
| **3.** | Enrolment Detail | |
| | **3.1** | Branch wise enrolment of students |
| | **3.2** | Gender wise classification of enrolled students |
| | **3.3** | Details of SC, ST and OBC students |
| | **3.4** | Details about religious Minority students |

Source: Institutional questionnaire

However, the total enrolment during 2015-16 was 8448 (Management wise distribution in Appendix-2, page no.180). Out of 8448 students, a total of 3884 students were eligible for

inclusion in the study, who belong to socially backward castes (SC, ST and OBC) and religious minority groups (Figure 3.1).

**Figure- 3.1: Total enrolled students and total students eligible for the study**




Source: Institutional questionnaire

### 3.3.2. Students Questionnaire

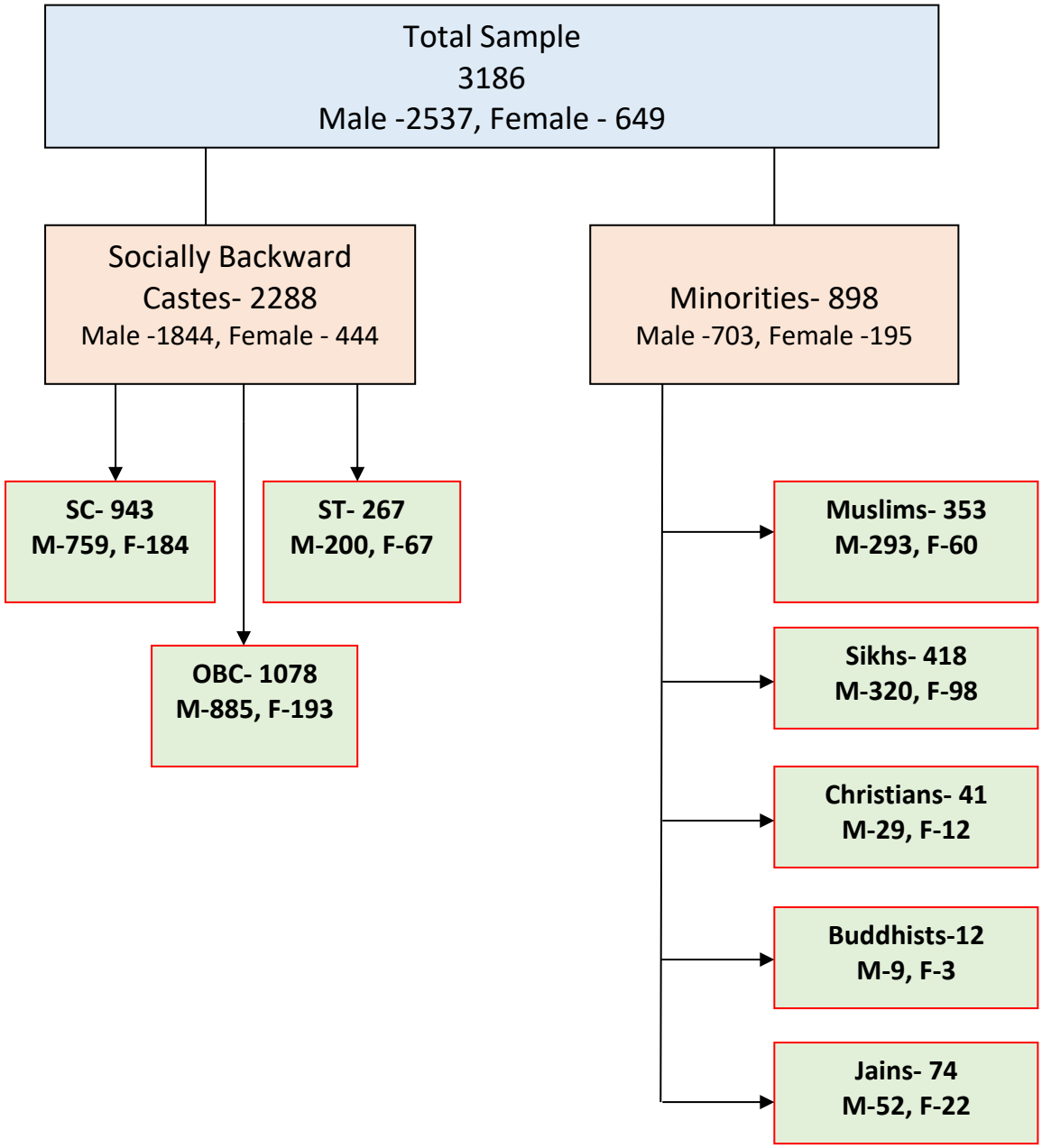
The second type of questionnaire was designed to obtain socio-demographic, economic, and educational information of the students belonging to socially backward castes (SC, ST, and OBC) and religious minorities who were enrolled in the B-Tech program during the academic year 2015-16. They were surveyed in the academic year 2018-19, when they were studying in the fourth year of the programmes. Fourth year students were purposively selected for the study, considering that they had completed three years of education, and were either already employed through placements or undergoing the placement process.

Out of the total 3884 eligible students to be included in the study, 541 students were either absent on the day of the survey or did not willing to participate. During data cleaning, 157 questionnaires were removed as they were not properly filled out. So, the final analysis has been done on the basis of responses from 3186 students (Figure-3.2).

Out of the total students covered in the study (3186), 15.94 percent were from central government institutions (IITD, NITD and JMI), 55.96 percent from state government

institutions, and 28.1 percent were from private institutions. Among them, 79.63 percent were male, and 20.37 percent were female. Regarding the distribution of students among socially backward castes (2288), 47.11 percent belonged to the OBC category, while 41.22 percent were from SCs, and 11.67 percent from STs. The distribution of students by religious minorities (898) shows that 46.55 percent were from the Sikh category, followed by 39.31 percent from the Muslim category, 8.24 percent from the Jain category, 4.56 percent from the Christian category, and 1.34 percent from the Buddhist category.

**Figure- 3.2: Details of the Respondents of the Study**



The student questionnaire was administered to collect information on socio-demographic, economic profile, educational profile, and placement details of the respondents, which are used in the analysis (Table-3.2). However, the major part of the analysis (objective 2, 3, 4 and 5) for the study is carried out with the help of data/information obtained from student questionnaire.

In the student's questionnaire, some of the questions such as occupation of parents, family annual income and senior secondary percentage was open ended. The respondents were asked to write the designation/profession of parents, actual annual income of the family and actual percentage obtained in senior secondary level. Later on, the occupation of mother and father were classified into four groups. Father's occupation category one is based on National Classification of Occupations (NCO) codes 3&4, these occupations such as: Librarians and Clerks of the University/College/School, Primary teachers, Nursing, Bank clerks, Technicians, Data entry Operators etc. Father's occupation category two is based on National Classification of Occupations (NCO) codes 1 & 2, these occupations such as: Lecturers/professors, Army and Navy Officers, Professionals, Legislators, Senior managers, Ministry, Doctors, Bank managers, Income-tax Officers, Railway jobs, Airport authority etc. Then, there is an occupation category three under National Classification of Occupations (NCO) codes 1 and 2, but it is specified only on engineers. Occupation category four is entrepreneurs. In case of mother occupation, category one is housewives, category two is based on National Classification of Occupations (NCO) codes 3&4, and category three is based on National Classification of Occupations (NCO) codes 1&2. Although around 37 in numbers, respondents' mothers were engineers, who are included in category three. Category 4 is entrepreneurs.

The annual income of the family has been classified into 4 groups like less than 6 lakhs, 6-12 lakhs, 12-18 lakhs and above 18 lakhs based on the studies conducted by Singh and Singh (2023) and Kumar and Shukla (2022). Similarly, the senior secondary percentage of respondents has also been classified into 4 groups based on their grade level. These classifications are 90% above, which are the outstanding graders, within 80-90%, which are A+ graders, within 70-80%, which are the A graders, less than 70%, which are the average performers. However, in the scope of analysis of Objective-4 (which is analysed only about minorities), senior secondary percentage of respondents is divided into two groups: Group-1, more than 80%, and Group-2, less than 80%. The reason behind this categorisation was the number of respondents falling under the percentage categories above 90% and below 70% was very small (around 100 in numbers), hence for greater clarity in the analysis, these categories of respondents have been combined into majority responses categories.

In addition, the religion of the respondents was also open-ended in the student questionnaire, which was classified into four groups for analysis: Hindu, Muslim, Sikh and others. Others included Jain, Buddhist, and Christian. As they were very less in numbers, therefore, the study is taking these three groups into a single category. Remarkably, in the analysis for Objective-4, where only minorities have been analysed, the religion of the respondents has been divided into two groups: Group 1 - Muslims and Group 2 - Other minorities. The motive of this classification is that the study wanted to make a comparison between Muslims and other minorities. Further, the caste of the respondents was divided into 4 groups: General, OBC, SC and ST, but in the case of analysis of objective-3 (which has analysis specifically about SC, ST and OBC students), caste of the respondents was classified into 2 groups i.e. Group-1 for SC or ST respondents, Group-2 for OBC respondents. However, the description and explanation of all the variables used for the analysis are discussed below (In table-3.2).

**Table-3.2: Description and explanation of variables used for analysis**

| Name of variables | Description | Explanation of Variables |
|---|---|---|
| Management | Management of the Institution | 1, if student has enrolled in Government Institution.<br>0, if student has enrolled in private Institution |
| Gender | Gender of student | 1, if male<br>0, if female. |
| Religion | Religion of student | 1, if Hindu<br>2, if Muslim<br>3, if Sikh<br>4, if Other minorities (Jain, Buddhist, Christian) |
| | | In the scope of analysis of Objective 4, which is analysed only about minorities.<br>Religion has been grouped in two:<br>1, if Muslim.<br>2, if Other minorities (Sikh, Jain, Buddhist, Christian). |
| Caste | Caste of student | 1, if General<br>2, if OBC<br>3, if SC<br>4, if ST |

| | | |
|---|---|---|
| | | In the analysis of Objective 3, which contains analysis especially about SC, ST and OBC students.<br>Caste has been grouped in two:<br>1, if SC/ST<br>2, if OBC |
| Fath_Edu / Moth_Edu | Education level of Father and Mother | 1, if secondary/senior secondary<br>2, if Graduation<br>3, if PG and above |
| Fath_Occu | Occupation of Father | 1, if father's occupation is under National Classification of Occupations (NCO) codes 3&4<br>2, if father's occupation is under National Classification of Occupations (NCO) codes 1&2<br>3, if father is an engineer, this profession also comes under National Classification of Occupations (NCO) codes 1&2.<br>4, if father is a businessman |
| Moth_Occu | Occupation of Mother | 1, if mother is housewife<br>2, if mother's occupation is under National Classification of Occupations (NCO) codes 3&4.<br>3, if mother's occupation is under National Classification of Occupations (NCO) codes 1&2.<br>4, if mother is a businessman |
| FA_Income | Family Annual Income of student | 1, if less than 6 lakhs<br>2, if within 6 to 12 lakhs<br>3, if within 12 to 18 lakhs<br>4, if above 18 lakhs |
| Senior_Sec_Per | Percentage/marks of student in senior secondary education | 1, if 90% above<br>2, if within 80-90%<br>3, if within 70-80%<br>4, if less than 70% |
| | | An exceptional case for the analysis of Objective 4: senior secondary percentage has been grouped in two:<br>1, if senior secondary percentage 80% above<br>2, if senior secondary percentage below 80% |
| Senior_Sec_Sch_Type | Management of school at senior secondary level | 1, if student from government schools<br>0, if student from Private schools. |
| Senior_Sec_Med | Medium of study at senior secondary level | 1, if student from English medium.<br>0, if student from non-English medium. |

| | | |
|---|---|---|
| Scholarship | Scholarship of student in graduate-level | 1, if student had received any scholarship<br>0, if student had no scholarship |
| Accommodation | Accommodation of student in graduate-level | 1, if Hosteller<br>0, if Non-hosteller |
| CGPA_of_Grad | Cumulative Grade Point Average (CGPA) of student at graduation level | Overall marks/CGPA of engineering graduate |
| Placement | Placement of student | 1, if student had received placement offers.<br>0, if student had not received placement offers. |
| Log_SALARY | log of student SALARY | Annual salary offered by placement. |

Source: students' questionnaire

Generally, in India, on-campus recruitment of engineering graduates takes place when they are in the third/fourth year of their programme through the placement cell of the institution. Different companies or organizations interested in recruiting students visit engineering institutions for on-campus recruitment and select graduates based on their requirements, taking into consideration factors such as CGPA, interviews, group discussions, or other selection criteria developed by the employers. The data collected from the survey on 'whether engineering graduates have got job offer or not' is taken as indicator of their prospect of getting employment. Students recruited through the placement cell, will join the organization after completion of their degree. Through the campus placement, some engineering graduates had received job offers while some had not. In the questionnaire, the students who had received job offers were asked to provide their annual salary. The annual salary which has been regarded as the earnings from their jobs.

### 3.3.2.1. Reliability and Validity of the instruments

Before going to the main survey from the student's questionnaire, a pilot survey also known as a pilot pre-test was conducted for the study to assess the reliability and validity of the questionnaire or instruments. The purpose of this pilot-testing is to evaluate the validity and reliability of the questionnaire or interview items, as outlined by Creswell (2012). The draft interview questionnaire was given to a sample of twenty-eight students. Based on their responses, the items were evaluated for clarity, relevance, and consistency. Items that were

unclear or inconsistent were either eliminated or improved accordingly. This process helped enhance the reliability and validity of the questionnaire by ensuring that it accurately captured the proposed hypotheses and produced reliable results. Also, conducting a pilot survey helps in identifying the research methods for the study, reducing errors, and increasing the overall accuracy of the main survey.

Further, statistical tools or methods such as correlation analysis and regression analysis were used to examine the relationships between the variables and test the reliability and validity of the data collected from the pilot survey as well as the main survey. In correlation analysis, appropriate values for reliability and validity of the data are typically reflected in the correlation coefficients. These coefficients indicate the strength and direction of relationships between variables. Here, all coefficient values are close to +1 or -1, indicating strong relationships. In regression analysis, the appropriateness of the data's reliability and validity is typically assessed through various statistical measures such as R-squared, adjusted R-squared, p-values, and standard errors of coefficients. Higher values of R-squared (R^2) and adjusted R-squared indicate better fit and greater reliability of the data. P-values indicate the statistical significance of the coefficients, statistical significance level typically, $P < 0.01$, $P < 0.05$, $P < 0.1$ suggest that the coefficients are statistically significant and the relationship between the independent and dependent variables is reliable. Here, maximum independent variables used for the analysis are statistically significant, which indicates the reliability of the data. Also, estimated data coefficients with smaller standard errors, indicate greater accuracy and reliability of the data. Overall, higher R-squared and adjusted R-squared values, statistically significant coefficients, and smaller standard errors, indicate greater reliability and validity of the data, which fits the survey data of this study. Additionally, the robustness of the regression model was examined by making changes to the independent variables. With changes in the independent variables in the regression model, no significant changes were found in the results, which clarified the robustness or strength of the data. By employing these methods, researchers ensure that their data are reliable, valid, and accurately represent the concepts of interest.

## 3.4. Descriptive Statistics

Descriptive statistics were used to provide a clear and concise summary of the socio-demographic and economic variables under investigation. Measures of central tendency, such as mean used to determine the average values of these variables, and measures of dispersion, such as standard deviation and range were used to assess the variability and spread of the data.

Descriptive statistical analysis allowed for a clear understanding of the distribution, patterns, and characteristics of the variables, enabling the researchers to draw meaningful conclusions about the impact of reservation on socio-economic outcomes in engineering education in Delhi.

## 3.5. Inferential Statistics

Inferential statistics has been used to analyse the third, fourth and fifth objectives of the study. The objectives of the study are to examine the factors that contribute to the academic performance, placement, and earnings of engineering graduates, with a specific focus on identifying differences between students. To achieve this, two different analytical techniques have been employed: (a) the sample-based Ordinary Least Squares (OLS) method to analyse and compare the academic performances of engineering graduates and (b) the Two-step Heckman selection model to study the labour market outcomes of engineering graduates. These techniques will enable a comprehensive analysis of the variables influencing academic performance, placement and earnings, providing valuable insights into the socio-economic aspects of engineering education in Delhi. The STATA-2014 software has been used for the analysis.

### 3.5.1 Ordinary Least Squares

The Ordinary Least Squares (OLS) method is a statistical technique employed in regression analysis to estimate the relationship between a dependent variable and one or more independent variables. In this study, OLS technique has been used to analyse and compare the academic performance of engineering graduates belonging to socially backward castes (SC, ST and OBC) and religious minorities. Further, it has also analysed and compared the academic performance of male and female engineering graduates. By applying this method, the study first identifies the variables that affect their academic achievement. Also, the study compares their academic performance between groups to gain a deeper understanding of the study. Separate analysis has been done for each group.

The equation for Ordinary Least Squares (OLS) can be expressed as follows:

$$Y_i = \alpha_0 + \alpha_1 X_{1i} + \alpha_2 X_{2i} + \ldots\ldots\ldots\ldots\ldots\ldots + \alpha_n X_{ni} + \varepsilon_1 \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

In this equation, $Y_i$ represents the dependent variable or the variable to be predicted, which here denotes the Cumulative Grade Point Average (CGPA) of engineering graduates.

$\alpha_0$ = the constant term.

$X_{1i}, X_{2i}, \ldots \ldots X_{ni}$ are the independent variables that affect $Y_i$.

$\alpha_1, \alpha_2, \ldots \ldots, \alpha_n$ are the coefficients representing the effect of each independent variable on $Y_i$.

$\varepsilon_1$= the error term, representing the difference between the observed value of $Y_i$ and the value predicted by the regression equation.

To analyse the variation in academic performances among engineering graduates, Ordinary Least Squares (OLS) method estimations are carried out separately for three groups i.e. castes (SC/ST and OBC), religious minorities (Muslims and Other Minorities), and gender (male and female). For each group, the independent variables are slightly different, with a single dependent variable, the CGPA of graduates, which reflects the overall academic performance of engineering graduates. The equations for which are given below:

***For the analysis and comparison between SC, ST and OBC students (objective-3):***

$$\textit{CGPA of Graduates } (Y_i) = \alpha_0 + \alpha_1 Management + \alpha_2 Gender + \alpha_3 Caste + \alpha_4 Fath\_Edu + \alpha_5 Moth\_Edu + \alpha_6 Fath\_Occu + \alpha_7 Moth.Occu + \alpha_8 FA\_Income + \alpha_9 Scholarship + \alpha_{10} Accomodation + \alpha_{11} Senior\_Sec\_Per + \alpha_{12} Senior\_Sec\_Med + \varepsilon_1 \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

***For the analysis and comparison among minorities (objective-4):***

$$\textit{CGPA of Graduates } (Y_i) = \beta_0 + \beta_1 Management + \beta_2 Gender + \beta_3 Religion + \beta_4 Fath\_Edu + \beta_5 Moth\_Edu + \beta_6 Fath\_Occu + \beta_7 Moth.Occu + \beta_8 FA\_Income + \beta_9 Senior\_Sec\_Per + \beta_{10} Senior\_Sec\_Med + \varepsilon_1 \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

***For analysis and comparison between male and female students (objective-5):***

$$\textit{CGPA of Graduates } (Y_i) = \Upsilon_0 + \Upsilon_1 Management + \Upsilon_2 Gender + \Upsilon_3 Caste + \Upsilon_4 Religion + \Upsilon_5 Fath\_Edu + \Upsilon_6 Moth\_Edu + \Upsilon_7 Fath\_Occu + \Upsilon_8 Moth.Occu + \Upsilon_9 FA\_Income + \Upsilon_{10} Senior\_Sec\_Per + \Upsilon_{11} Senior\_Sec\_Sch\_Type + \Upsilon_{12} Senior\_Sec\_Med + \varepsilon_1 \ldots\ldots (4)$$

Here, all the independent variables comprise Management, Gender, Religion, Caste, Father education, Mother education, Father occupation, Mother occupation, Family annual income, Scholarship, Accommodation, Senior secondary percentage, Senior secondary school type and Senior secondary medium. The description and explanation of all the variables used in OLS regression model are discussed in Table-3.2.

### 3.5.2 Two-step Heckman Selection Model

The study uses Two-step Heckman Selection Model (Heckman, 1979) to analyse labour market status of engineering graduates (employment/placement and earnings). This model employs a double sample selection framework and contemplates two-part selection decisions, first, the decision to employment/placement (students get placement or not) and second, their earnings/ salaries from employment. However, the study can only observe the salaries of those students who have got the placement. As a result, a potential issue of selection bias arises in this context, and this is why it is not appropriate to use the whole sample to execute OLS regression model.

The rationale behind using Two-step Heckman model is to overthrow the sample selection bias problem while analysing status of earnings among engineering graduates. The model contemplates two dependent variables for analysis. The first stage's dependent variable is the "decision to get placement". where takes the value 1, if the student had received placement and zero otherwise (Binary variable). Then, the second stage's dependent variable is the annual earnings or salaries (in logarithmic form) of engineering graduates and the value takes their annual salary amount for employed/placed student and zero who has not got any placement/employment (Continuous variable).

In the first step (stage-1, selection model), the probability of getting placement offer is estimated using the probit model, and from this first step equation, the inverse Mills ratio is calculated and added as an explanatory variable into the student earnings equation; this eliminates the selection bias. Additionally, to estimate the selection model, it is compulsory to comprise at least one instrument variable in the first step equation (placement equation), which is not included in the earnings equation. If the independent variables are the same in both the equations, there is usually collinearity between the predicted inverse Mills ratio and the determining factor of the earning equation. Thus, the study constructs two instrumental

variables (senior secondary percentage and senior secondary medium) that are assumed to affect the employment decision only and not the decision of how much to earn from it.

The two equations of this model for estimating the results are as follows:

The Selection model: $X_i\alpha + \varepsilon_1 > 0$ ... ... ... ... ... ... . . (5)

The regression model: $Y_i = W_i\beta + \varepsilon_2$ ..... (6)

Following assumption holds: $\varepsilon_1 \sim N(O, 1)$ ... ... ... .... $(6a)$

$\varepsilon_2 \sim N(O, \sigma)$ ... ... ... .... $(6b)$

Corr( $\varepsilon_1, \varepsilon_2$) = $\rho$ ... .... $(6c)$

Equation (5) represents the selection model, where $X_i$ is a vector of independent variables, α is a coefficient vector, and ε1 is the error term. This equation indicates that the independent variables Xi affect the probability of selection into the sample, and the error term ε1 follows a standard normal distribution.

Equation (6) represents the regression model, where Yi is the dependent variable, Wi is a vector of independent variables, β is a coefficient vector, and ε2 is the error term. This equation shows the linear relationship between the independent variables Wi and the dependent variable Yi, with an error term ε2.

Assumptions (6a), (6b), and (6c) describe the properties of the error terms ε1 and ε2:

Equation (6a) states that the error term ε1 in the selection model follows a standard normal distribution, denoted by N (0,1). This means that ε1 has a mean of zero and a standard deviation of one, indicating that it is normally distributed.

Equation (6b) states that the error term ε2 in the regression model follows a normal distribution with mean zero and some standard deviation σ. This indicates that the error term ε2 is normally distributed but allows for heteroscedasticity, as its variance may not be constant.

Equation (6c) specifies the correlation between the error terms ε1 and ε2 as ρ. This correlation captures the relationship between the errors in the selection and regression models. A non-zero

correlation indicates that there is some relationship between the errors in the two models, which can affect the estimation of the parameters.

To examine the heterogeneity in estimated probabilities of placement and earnings in engineering education, Heckman selection model estimations are carried out separately by castes (i.e. for SC/ST and OBC), religious minorities (i.e. for Muslims and Other Minorities), and gender (i.e. for male and female). The independent variables and instrumental variables are same for all three groups, and for this model each group includes two dependent variables, i.e. placement and earnings. However, where the study has specifically emphasized the outcome of placement and earnings among caste groups, religion has been omitted as an independent variable. Similarly, when the study focuses only on religious minority groups, caste is not included as an independent variable. Following are the equations of the Heckman selection model for each group with variables:

***For Caste Groups (Objective-3):***

The Selection model for placement (Stage-1, equation-7)

$$Pacement = \alpha_0 + \alpha_1 Management + \alpha_2 Gender + \alpha_3 Caste + \alpha_5 Senior\_Sec\_Per + \alpha_6 Senior\_Sec\_Med + \alpha_7 CGPA\ of\ graduates + \varepsilon_1 \dots\dots\dots\dots\dots (7)$$

The regression model for Earnings (Stage-2, Equation 8):

$$Earnings = \beta_0 + \beta_1 Management + \beta_2 Gender + \beta_3 Caste + \alpha_5 CGPA\ of\ graduates + \varepsilon_2 \dots\dots\dots\dots\dots\dots (8)$$

***For Religion Groups (Objective-4):***

The Selection model for placement (Stage-1, equation-9)

$$Pacement = \alpha_0 + \alpha_1 Management + \alpha_2 Gender + \alpha_4 Religion + \alpha_5 Senior\_Sec\_Per + \alpha_6 Senior\_Sec\_Med + \alpha_7 CGPA\ of\ graduates + \varepsilon_1 \dots\dots\dots\dots\dots\dots (9)$$

The regression model for Earnings (Stage-2, Equation 10):

$$Earnings = \beta_0 + \beta_1 Management + \beta_2 Gender + \beta_4 Religion + \alpha_5 CGPA\ of\ graduates + \varepsilon_2 \dots\dots\dots\dots (10)$$

***For Gender (Objective-5):***

The Selection model for placement (Stage-1, equation-11)

$$Pacement = \alpha_0 + \alpha_1 Management + \alpha_2 Gender + \alpha_3 Caste + \alpha_4 Religion + \alpha_5 Senior\_Sec\_Per + \alpha_6 Senior\_Sec\_Med + \alpha_7 CGPA\ of\ graduates + \varepsilon_1 \dots\dots\dots\dots\dots\dots (11)$$

The regression model for Earnings (Stage-2, Equation 12):

$$Earnings = \beta_0 + \beta_1 Management + \beta_2 Gender + \beta_3 Caste + \beta_4 Religion + \alpha_5 CGPA\ of\ graduates + \varepsilon_2 \dots\dots\dots\dots\dots\dots (12)$$

All the independent variables for this model include Management, Gender, Caste, Religion, and CGPA of graduates, two instrumental variables are Senior secondary percentage, and Senior secondary medium, where the two dependent variables are placement and earnings. The description and explanation of all the variables used in Two-step Heckman selection model has been discussed in Table-3.2.

## 3.6. To Sum up the Chapter

The chapter gives a detailed analysis of objectives of the study, hypotheses emerging from the objectives, population of the study and selected sample, research tools used in the process of data collection. A brief analysis has also been given about the research technics used for drawing inferences i.e. Ordinary Least Squares (OLS) method and the Two-step Heckman selection model.

# CHAPTER -4
# DESCRIPTIVE ANALYSIS (Objective 1 &2)

## 4.1. Background

The primary focus of this chapter is to discuss the reservation policies and other affirmative actions implemented by degree-level engineering institutions in Delhi during the academic year 2015-16 (Objective-1). Here, the emphasis is on the academic year 2015-16 as the students enrolled during this year are targeted for this study, and are used for detailed analysis in relation to the other objectives of the study. Subsequently, a comprehensive discussion on socio-demographic and economic background of the beneficiaries of these programs has also been done. This discussion aims to provide insights into the student groups such as socially backward castes (SC, ST and OBC), and religious Minorities, benefiting from these reservation policies and affirmative actions (Objective-2). Furthermore, a discussion has been made on the basis of gender, covering both groups as a whole.

## 4.2. Objective-1: Affirmative Programs Offered by Degree Level Engineering Institutions in Delhi

This section contains a census of the affirmative programs offered by degree-level engineering institutions in Delhi. Even those two institutions have been included here which did not participate for the other four objectives of the study. The institutions covered one Indian Institute of Technology (IIT), one National Institute of Technology (NIT), one central university, Jamia Millia Islamia, one government-funded deemed university, Jamia Hamdard, along with nine state government institutions[9] and seven private institutions[10]. These

[9] The nine institutions of the state government are DTU, NSUT, IIITD, IGDTUW, CBPGEC, DITE, NPTI AIACTR, and GBPGEC.

[10] The seven private institutions included in the study, namely BPIT, MSIT, ADGITM, HMR-ITM, MAIT, GTBIT, and BVCE, are affiliated with Guru Gobind Singh Indraprastha University (GGSIPU), a state government university in Delhi certified as an affiliating and teaching University. As a result of this affiliation, six private institutions follow to the reservation policies set by GGSIPU, with GTBIT being the only exception as it functions

institutions provide a number of affirmative programmes, which have been categorized into three parts for clarity: (i) Reservation in enrolment, (ii) Establishment of special institutions, and (iii) Other affirmative measures.

### 4.2.1. Reservation in Enrolment

All engineering institutions of Delhi managed by central, state, and private follow the reservation policies in enrolment implemented by the central government for Scheduled Castes (SC), Scheduled Tribes (ST), Other Backward Classes (OBC), and Persons with Disabilities (PWD). As per the central government guidelines, 15% of total seats are reserved for Scheduled Castes (SC), 7.5% for Scheduled Tribes (ST) and 27% for the students of the Other Backward Classes (OBC) category. Here, the exception institutions include JMI, JH and GTBIT, which do not follow these reservation policies for SC, ST and OBC candidates, as they function as minority institutions. However, all institutions provide reservation for students with disabilities ranging from a minimum of 3% to a maximum of 5% in their enrolment.

Additionally, in all state government and private institutions, 85% of the total seats are reserved for candidates from the Delhi region[11], and the rest 15% are reserved for candidates from outside the Delhi region[12]. On the other hand, all private institutions in Delhi have 10% management quota. This 10% management quota in private engineering institutes generally refers to the percentage of seats that are reserved for the students' admission at the decision of the management or administration. These seats are not filled through the regular admission process, but are allotted directly to the candidates by the management based on various criteria, which may include academic merit, extra-curricular achievements or other considerations.

Also, Kashmiri migrants are entitled to reservation in admission, with specific provisions across different institutions. Beyond the regular admission, one additional seat is allotted for candidates from J&K (Jammu and Kashmir) in IITD, NITD, DTU, NSUT, IGDTUW and IIITD. Whereas 5% of the total seats in JMI are reserved for Kashmiri migrants, ensuring that the count does not exceed two additional seats in the programs offered. A quota of 5% of the

as a minority institution. These six private institutions align their admission processes with the reservation policies of GGSIPU, including the reservation of seats for categories such as SC, ST, OBC, PWD, etc.

[11] A candidate who has passed 11th and 12th class qualifying examination from a recognized school located in Delhi.

[12] A candidate who has passed 11th and 12th class qualifying examination from a recognized school located outside Delhi.

total seats is reserved for children of widows of defence personnel (CWD) in DTU, NSUT, IGDTUW and IIITD in addition to the regular admission.

There is reservation in enrolment for Single Girl Child (SG) in DTU and NSUT, one seat in each branch of the normal intake. However, this only applies to girls from Delhi and not to girls from other states. In DTU one seat in each branch is reserved for Central/State Board topper, over and above the normal intake. Foreign/Non-Resident Indians (NRIs) candidates are also admitted through the Direct Admission of Students Abroad (DASA) schemes in JMI, NIT, DTU, NSUT, IIITD, and IGDTUW, but not more than 15% of the regular seats. A brief description of these reservation policies in enrolment is given in Table 4.1.

**Table 4.1: Reservation in Enrolment**

| S. N | Category | Institution wise reservation seats |
|---|---|---|
| **1** | SC, ST and OBC | All the institutes have reservation of 15% for SC, 7.5% for ST and 27% for OBC, but three minority institutes JMI, JH and GTBIT do not follow this reservation policies for these categories. |
| **2** | Persons with Disability | In all Institutions, ranging from 3 to 5%. |
| **3** | Residents of Delhi | 85% of the total seats in all state government and private institutions. |
| **4** | Management quota | In all private institutions 10% of the total seats are reserved as management quota. |
| **5** | Kashmiri Migrant | One seat over and above the normal intake in IITD, NITD, DTU, NSUT, IGDTUW and IIITD, while two seats in JMI |
| **6** | Children of Widows of Defence Personnel (CWD) | 5%, over and above the normal intake in DTU, NSUT, IGDTUW and IIITD. |
| **7** | Single girl Child | One seat in each branch in DTU and NSUT |
| **8** | Central/State board topper | One seat in each branch at DTU |
| **9** | Foreign Candidates | Not more than 15% of the regular seats in JMI, NIT, DTU, NSUT, IIITD, and IGDTUW. |

Apart from this, 14% special quota for girls in enrolment at IITD has been implemented since 2018. Since 2019, the central government has implemented 10% admission quota for Economically Weaker Section (EWS) candidates in all educational institutions, which is also being followed by all engineering institutes in Delhi.

### 4.2.2. Establishment of Institutions

There are two engineering institutions in Delhi, namely Jamia Millia Islamia and Jamia Hamdard, which have been established as minority institutions. They provide 70% reservation for Muslim students, thereby leading significant participation of Muslims in engineering education. Similarly, Guru Tegh Bahadur Institute of Technology (GTBIT), a private engineering college, is associated with another minority community i.e. Sikh, and provides 75% reservation for Sikh students. This reservation policy ultimately increases their participation in engineering education. Additionally, there exists an engineering university in Delhi exclusively for female candidates, known as Indira Gandhi Delhi Technological University for Women (IGDTUW), which encourages female participation in engineering field.

### 4.2.3 Other Affirmative Programmes

In addition to reserved seats in enrolment, and the establishment of specialized institutions, engineering institutions also provide several other affirmative programs to promote student engagement in engineering education. These programs are further detailed and briefly explained in Table 4.2.

Some institutes offer a percentage relaxation in total marks for specific categories during admission. In JMI, there is a relaxation of 5% in the aggregate marks for N.C.C cadets and outstanding players. A private college GTBIT also provides the same relaxation for children of widows of Defence Personnel (CWD) candidates. In IITD and NITD, there is a 10% relaxation in aggregate marks for SC, ST, and PWD candidates. Similarly, DTU, NSUT, and IIITD offer a 10% relaxation for SC, ST, and PWD candidates, along with a 5% relaxation for OBC candidates. Additionally, IGDTUW provides a 5% relaxation in aggregate marks for SC, ST, and PWD candidates.

Out of the twenty degree-level engineering institutions in Delhi, around 13 institutions provide the benefit of some percentage of fee concessions or waivers to the economically disadvantaged students during admissions. Particularly, in some central and state Government institutions,

namely IITD, DTU, NSUT, IIITD, IGDTUW, AIACTR, JH, and DITE, candidates belonging to economically disadvantaged backgrounds get the benefit of fee waivers during their admission. In IITD, there is a provision to waive the full admission fee for SC, ST and PWD students. Even in all the private engineering institutions in Delhi, some percentage of fee concessions are available for these candidates. However, this provision is totally based on the minimum family annual income, ranging from less than Rs 2 lakh to less than Rs 4.5 lakh, and this criterion varies depending on the institution.

Apart from tuition fee waivers, certain institutions also provide other forms of financial assistance to support students from marginalised groups or to encourage students in engineering education. Notably, IITD, DTU, IIITD, JH, ADGITM, GTBIT, and BPIT institutions provide such assistance. This financial support may come from various sources such as specific government agencies, private companies, charitable foundations, alumni donations, institutional scholarships facilitated by the chairman of the institutions, and university-specific financial funds to reward top-performing students. The allocation of this financial assistance is typically based on criteria such as high CGPA, class-ranking (topper students in each branch), exceptional performance in a particular subject within the branch, high JEE Main scores, and considerations for lower socio-economic groups based on social caste.

In IITD, financial assistance is allocated to students based on merit criteria such as high CGPA, and also on caste considerations, particularly for students from lower social caste groups (SC and ST). In some cases, free accommodation facilities and meal services are provided to SC and ST students based on their low family annual income. The institute provides financial awards to students who perform exceptionally well in a particular subject within their branch, as well as awards of Rs 1000 per month to those included in the JEE merit list. These supports at IITs are usually provided through donors or by the institutional welfare funds.

In DTU, annual financial awards are provided to top performing student in each branch, funded by university-specific financial allocations, aiming to encourage academic excellence among students. Similarly, in IIITD, the Chairman's Merit Scholarship is awarded to students with outstanding academic performance, including those with a high CGPA (above 8.5 CGPA), the class topper, and those with a JEE Main rank below 2000. In the institution recipients of the Chairman's Merit Scholarship are not eligible for the income-linked fee waiver scheme.

A minority institute Jamia Hamdard (JH) provides free accommodations and meal services to disadvantaged Muslim students based on their low family annual income, supported by specific financial provisions of the university. Even some private engineering institutions, namely BPIT, ADGITM and GTBIT also provide extra financial assistance to students from economically disadvantaged backgrounds, beyond tuition fee waivers. This financial assistance provided in private institutions is often funded by donors or the institution's chairman. However, within each institution, there exists a policy that allows students to select only one type of financial assistance, whether it be tuition fee waivers or other available financial aid options.

Moreover, institutions provide various academic support programs to encourage students in their educational endeavours. These programs include informational sessions, workshops, seminars, conferences, academic counselling, peer-led study groups, and campus tours for academic development. As part of affirmative action, these initiatives are designed to assist engineering students, particularly those who face academic difficulties, in overcoming challenges during their educational journey. The programs provide support in study skills, time management, test preparation techniques, academic writing, and more, all of which contribute to improving academic performance. In particular, IITD, DTU, NSUT, IGDTUW, and IIITD regularly offer such programs, and also organize special programs for marginalised groups.

Furthermore, certain institutions provide supplementary tutoring or coaching to students who need additional support to succeed in their coursework. These classes target students who are weak in specific subjects or topics and provide extra instruction and practice to help them improve their understanding and performance. Especially, IITD, DTU, NSUT, IIITD, JMI, and JH are among the institutions that provide such programs for marginalized groups.

All engineering institutions provide access to libraries, online databases, academic journals, internet facilities, various technologies, and other resources to support students' research and learning requirements. DTU provides textbooks and stationery items to students from lower socio-economic backgrounds like SC and ST.

In each institution has been set up a special placement cell to transition students from education to employment. Career counselling services are also important components of the institutions, aiming to guide students towards successful career paths. These services typically include personalized career counselling sessions, workshops, seminars, internship opportunities, and

mock interviews to prepare students for the job market. Institutions often collaborate with industry partners and organize campus recruitment drives, and networking events to connect students with potential employers. Some institutions like IITD, DTU, NSUT, IIITD and IGDTUW offer resume-building workshops, hackathon, industrial tours, more internship chances, pre-placement talk sessions, alumni support system with career-related concerns, and skill development programs to enhance the employability of students. Additionally, these institutions conduct special hackathons and counselling sessions focused on women, and collaborate with companies that include women intake programs to secure female placements. Particularly, IITD has an exclusive Office of Career Services (OCS). The main goal is to prepare engineering graduates with the necessary skills, knowledge, and resources to secure fulfilling employment opportunities in their respective branches.

All institutions provide essential equipment such as ramps, accessible toilets, lifts, and wheelchairs for the convenience of physically disabled students. Some institutions, namely IITD, DTU, NSUT, IIITD, JMI, IGDTUW, and JH, provide a variety of support services to facilitate the academic and overall success of students with disabilities. These services include specialized campus accommodations, note-taking assistance, extended exam time, alternative exam formats, peer support programs, separate counselling services, and accessibility-focused workshops. The aim is to ensure equal educational opportunities for students with disabilities, promoting their academic achievement.

Out of the total twenty institutions, only fourteen institutions provide hostel facilities. Among these, eleven institutions have separate girls' hostel facilities, namely IITD, NITD, DTU, NSUT, IIITD, JMI, JH, BVCE, BPIT, MSIT, and NPTI. Additionally, JMI and DTU offer separate hostel facilities for Foreign/NRI candidates.

Student Welfare (SW) funds in the institutions address the problems faced by the students, focuses more on meritorious students, and marginalized groups. Especially, in IITD, DTU, NSUT, IIITD, NITD, and IGDTUW, there exists a separate SW fund for marginalised groups like women, minorities, SC, ST, and OBC students. The fund supports their academic and financial needs and also tries to solve the problem of discrimination faced by these students.

**Table 4.2: Other Affirmative Programmes**

| S. N | Category | Institution wise affirmative programmes |
|---|---|---|
| **1.** | Relaxation percentage in aggregate marks | In JMI, 5% for N.C.C cadets and outstanding players.<br>In GTBIT, 5% for CWD candidates.<br>In IITD and NITD, 10% for SC, ST, and PWD.<br>In DTU, NSUT, and IIITD 10% for SC, ST, and PWD, along with a 5% for OBC candidates.<br>In IGDTUW 5% for SC, ST, and PWD candidates. |
| **1** | Tuition fee waiver | Fee waivers for economically disadvantaged students are available at IITD, DTU, NSUT, IIITD, IGDTUW, AIACTR, JH, and DITE. Private institutions also provide fee concessions for these groups. It is determined by the minimum family annual income, ranging from less than Rs 2 lakh to less than Rs 4.5 lakh, and the specific income limits and waiver amounts vary among institutions. |
| **4.** | Other financial assistance and grants | Besides tuition fee waivers, institutions namely IITD, DTU, IIITD, JH, ADGITM, GTBIT, and BPIT provide several other forms of financial assistance. These include aids for high CGPA, class-ranking, exceptional performance in a particular subject within the branch, top JEE Main scores, and considerations for lower social caste groups (SC and ST). |
| **3.** | Offering academic support programs | All institutions provide various academic support programs, such as informational sessions, workshops, seminars, conferences, academic counselling, peer-led study groups, and campus tours for academic development.<br>IITD, NITD, DTU, NSUT, IGDTUW and IIITD offer such programs regularly and they organize special programs for marginalised groups. |

| | | |
|---|---|---|
| **5.** | Additional Tutoring or coaching classes | IITD, DTU, NSUT, IIITD, JMI, and JH provide additional tuition or coaching for students from marginalized groups, who actually struggle in their academic journey. |
| **8.** | Providing books, stationery items and other educational resources | DTU provides textbooks and stationery items to students from lower socio-economic backgrounds like SC and ST. |
| **7.** | Career counselling and placement services | Each institute has established a placement cell. Especially, IITD, DTU, NSUT, IIITD, and IGDTUW provide resume-building workshops, hackathon, industrial tours, better internship opportunities, pre-placement talk sessions, alumni support system with career-related concerns and skill development programs to enhance students' employability. They also organize women's hackathons, and collaborate with companies that include women intake programs to secure female placements. |
| **6.** | Disability support services | IITD, NITD, DTU, NSUT, IIITD, JMI, IGDTUW, and JH provide special campus accommodations, note-taking assistance, extended exam timings, alternative exam formats, peer support programs, counselling services, and accessibility-focused workshops for students with disabilities. |
| **9.** | Separate hostel facility | Eleven institutions have separate girls' hostel facilities, namely IITD, NITD DTU, NSUT, IIITD, JMI, JH, BVCE, BPIT, MSIT, and NPTI. Additionally, JMI and DTU offer separate hostel facilities for Foreign/NRI candidates. |
| **10.** | Student Welfare (SW) Fund | SW funds in institutions address student issues. Especially, in IITD, DTU, NSUT, IIITD, NITD, JMI JH and IGDTUW, a separate fund provides for marginalised groups such as women, minorities, SC, ST, and OBC students. This fund supports their academic and financial needs and aiming to reduce discrimination. |

In summary, government engineering institutes, namely IITD, NITD, DTU, NSUT, IIITD, IGDTUW, JMI, and JH offer various reservation policies in enrolment, and other affirmative programs to support marginalized groups and encourage participation in engineering education. However, increasing these initiatives could further enhance effectiveness. Other government institutions in Delhi also implement reservation policies but should also focus on providing more affirmative programs, especially for marginalized groups. Particularly, Muslim minority institutes like JMI and JH from government category, and a private institute GTBIT for Sikh minority, demonstrate higher participation rates of these minority groups, indicating the effectiveness of targeted initiatives. Interestingly, private institutions in Delhi also provide some affirmative programs including reservation policies, but they should expand their efforts further.

## 4.3. Objective- 2: Socio- Demographic and Economic status of Sample Respondents

It is often argued that opportunities through reservation and other affirmative actions are availed by well-off groups among the students of socially backward castes (SC, ST and OBC) and minorities in India (Weisskopf, 2004). In this background, the second objective of this study examines the socio-demographic and economic characteristics of respondents. This is discussed for SC, ST, and OBC students as well as students belonging to religious minorities. The socio-demographic and economic factors are also discussed gender wise, covering all sample respondents. The variables such as location of the residence, family type, parental education, occupation, and family income have been selected to discuss the second objective of the study. The discussion is divided into three parts (4.3.1 to 4.3.3): the first part discusses the socio-demographic and economic status of SC, ST, and OBC respondents, the second part covers the socio-demographic and economic status of respondents belonging to minority communities, and the third part addresses the socio-demographic and economic status of respondents classified by gender

### 4.3.1 Socio-demographic and economic status of SC, ST and OBC respondents

The first variable which has been considered for the respondents is their residential status. More than 90% of the respondents in the study were from urban areas and the rest were from rural

areas. Relatively less ST students were from urban areas as compared to SC and OBC students. More than 90% students from SC and OBC were from urban areas whereas this figure is 76.4% for ST. The finding clearly shows that economic conditions in urban areas may be more conducive for engineering education. The economic condition may be classified in to two Micro and macro. The micro conditions may consist of family type, parent's education and occupation, engineers in the family, family Income etc, whereas macro condition may consist of availability of coaching institutes, quality of secondary education etc. The table 4.3 provides a glimpse of micro condition of the respondents. The data indicates that there is a higher representation of students from nuclear families (90.21%) compared to joint families where the share is 9.79%. The prevalence of nuclear families may suggest various socio-economic factors influencing family dynamics and living arrangements among the student population, potentially impacting their educational experiences and opportunities (Nato, 2016).

**Table- 4.3: Socio-demographic and economic status of SC, ST and OBC Students**

| Sample Constituents' | SC Students | ST Students | OBC Students | Total Students |
|---|---|---|---|---|
| Residence | | | | |
| Urban | 93.53 | 76.40 | 90.72 | 90.21 (2064) |
| Rural | 6.47 | 23.60 | 9.28 | 9.79 (224) |
| Family Type | | | | |
| Joint | 9.76 | 25.09 | 11.87 | 12.54 (287) |
| Nuclear | 90.24 | 74.91 | 88.13 | 87.46 (2001) |
| Father Education | | | | |
| Secondary | 10.39 | 10.86 | 5.38 | 8.09 (185) |
| Graduation | 40.19 | 51.31 | 29.22 | 36.32 (831) |
| PG &Above | 49.42 | 37.83 | 65.40 | 55.59 (1272) |
| Mother Education | | | | |
| Secondary | 16.01 | 25.84 | 10.67 | 14.64 (335) |
| Graduation | 66.70 | 56.55 | 53.25 | 59.18 (1354) |
| PG &Above | 17.29 | 17.60 | 36.09 | 26.18 (599) |
| Father Occupation | | | | |
| 3&4 NCO$^{\#}$ | 18.03 | 22.47 | 14.75 | 17 (389) |
| 1&2 NCO$^{\#\#}$ | 34.25 | 35.58 | 44.53 | 39.25(898) |

| | | | | |
|---|---|---|---|---|
| 1&2 NCO## (Engineer) | 11.45 | 7.12 | 11.32 | 10.88 (249) |
| Entrepreneur | 36.27 | 34.83 | 29.41 | 32.87 (752) |
| Mother Occupation | | | | |
| House Wife | 68.93 | 71.16 | 55.01 | 62.63 (1433) |
| 3&4 NCO# | 11.77 | 15.73 | 16.79 | 14.60 (334) |
| 1&2 NCO## | 12.94 | 8.61 | 24.58 | 17.92 (410) |
| Entrepreneur | 6.36 | 4.49 | 3.62 | 4.85 (111) |
| Family Annual Income | | | | |
| Less than 6 Lakh | 26.41 | 31.84 | 19.11 | 23.60(540) |
| 6 to 12 lakhs | 23.86 | 24.34 | 18.09 | 21.20 (485) |
| 12 to 18 lakhs | 32.66 | 32.58 | 29.68 | 31.25 (715) |
| 18 lakhs Above | 17.07 | 11.24 | 33.12 | 23.95 (548) |
| Total | 943(41.22) | 267(11.67) | 1078(47.12) | 2288 |

Source: Data estimation based on primary survey.

Notes:(i) 3 &4 NCO#, represents occupations classified under National Classification of Occupations (NCO) codes 3 and 4, these occupations such as: Librarians and Clerks of the University/College/School, Primary teachers, Nursing, Bank clerks, Technicians, Data entry Operators etc.

(ii) 1&2 NCO##, represents occupations classified under National Classification of Occupations (NCO) codes 1 and 2, these occupations such as: Lecturers/professors, Army and Navy Officers, Professionals, Legislators, Senior managers, Ministry, Doctors, Bank managers, Income-tax Officers, Railway jobs, Airport authority etc.

The survey includes parental educational background which is being an important factor in determining the access to engineering education. Fathers of most of the respondents (55.59%) were having post graduate degree, followed by graduate degree (36.32%). A very small proportion have up to the secondary level of education (8.09%). Mothers of a significant percentage of respondents have completed graduation (59.18%) and hold post-graduate degrees or above (26.18%). It may be inferred that parents with higher education positively influences their children for engineering education (Pearson & Miller, 2012; Craig, et al., 2021). Next variable which is very important for the study is parent's employment. A notable proportion of fathers (39.25%) of respondents are holding positions which comes under 1&2 of the NCO category. One and two categories of NCO may be called as officers and manager. Occupation of the parents may influence the educational choices of their wards. For instance, studies find that parents with a high occupational background are more likely to encourage their children to

pursue engineering, technical, and medical courses (Plasman, et al., 2021; Zou, 2023). Among the total respondents, 32.87% of fathers are entrepreneurs, 10.88% are engineers, and 17% are employed in 3 and 4 NCO category jobs, whereas the majority (39.25%) hold 1 and 2 NCO category jobs. However, the majority of students' mothers are housewives (62.63%), followed by 14.6% employed in 3 and 4 NCO category jobs, 17.92% employed in 1 and 2 NCO category jobs, and a small percentage are entrepreneurs (4.85%). The occupation of parents, particularly fathers, plays an imperative role in enrolling students in engineering education, while the impact of mothers' occupation is comparatively less pronounced (Jarvie-Eggart, et al., 2020; Zou, 2023).

The income levels of students' families vary, with the largest segment falling into the '12 to 18 lakhs' income category (31.25%), followed by 'Less than 6 Lakhs' (23.60%), '6 to 12 lakhs' (21.20%), and '18 lakhs above' (23.95%). The income level of a family plays a crucial role in students' access to engineering education, which is often associated with significant costs such as tuition fees, books, and materials. Higher income levels may afford families the financial means to support their children's pursuit of engineering education through access to quality coaching, educational resources, and other opportunities that enhance their academic credentials. Conversely, lower-income families may face greater financial barriers to accessing engineering education, potentially limiting opportunities for their children to pursue this field (Nusselder, et al., 2023; Anderson, et.al., 2023). Overall, the table provides insights into the residential backgrounds, family types, parental educational levels, occupational profiles, and family income distributions among the students under consideration.

### 4.3.2 Socio-demographic and economic status of respondents belonging to minority communities

Here, table-4.4 presents a discussion about the socio- demographic and economic background of respondents from minority communities. There is also a rural-urban gap in enrolment to engineering education of minority students. A higher percentage of students from urban areas are joining engineering education than students from rural areas across all minority groups. It is astonishing that there is not even a single student in Jain community who is from the rural India. The number of minority students from rural areas is considerably less (11.69%) compared to urban areas (88.31%) in engineering education. This may be due to the socio-economic backwardness in rural areas, cultural effects, lack of proper transportation and lack

of knowledge among the parents and students about engineering education (Ayisha, et. al., 2022). It may suggest better residential location has a positive impact on students' educational progress and future planning.

The next variable to be considered is the family type of minority students, which is discussed here. As already discussed in section 4.3.1, here also most of the respondents were from nuclear families. Just for the sake of comparison, the highest percentage of Jain respondents (95.95%) came from nuclear families, while the lowest share was among Buddhist respondents (83.33%). This was followed by Christian respondents at 90.24%, Sikhs at 89.95%, and Muslims at 86.12%. The overall data shows that among Minorities, 11.14% students in joint families, while 88.86% live in nuclear families. This pattern extends across all religious groups, with varying proportions in joint and nuclear family. Interestingly, it indicates that among Jain students, only around 4% of students come from joint family households, while the majority, around 95.95%, come from nuclear family setups. Generally, families with more members have less resources left for education and parents living under joint family or having additional family members reduce the chances of a student access to engineering education. Because the moderate strength evidence in India is that engineering courses cost much more than general courses (Parihar, et al., 2017; Brisbane, et al., 2019).

**Table- 4.4: Socio-demographic and economic Status of Minority students**

| Sample Constituents' | **Muslims** | **Christians** | **Buddhists** | **Jains** | **Sikhs** | **Overall** |
|---|---|---|---|---|---|---|
| Residence | | | | | | |
| Urban | 84.42 | 97.56 | 91.67 | 100 | 88.52 | 88.31(793) |
| Rural | 15.58 | 2.44 | 8.33 | 0 | 11.48 | 11.69(105) |
| Family Type | | | | | | |
| Joint | 13.88 | 9.76 | 16.67 | 4.05 | 10.05 | 11.14(100) |
| Nuclear | 86.12 | 90.24 | 83.33 | 95.95 | 89.95 | 88.86(798) |
| Father Education | | | | | | |
| Secondary | 11.61 | 4.88 | 0 | 2.71 | 7.18 | 8.35(75) |
| Graduation | 43.06 | 19.51 | 50 | 22.97 | 51.91 | 44.54(400) |
| PG &Above | 45.33 | 75.61 | 50 | 74.32 | 40.91 | 47.11(423) |

| | | | | | | |
|---|---|---|---|---|---|---|
| Mother Education | | | | | | |
| Secondary | 17.28 | 9.76 | 8.33 | 2.7 | 15.55 | 14.81(133) |
| Graduation | 63.46 | 36.58 | 75 | 48.65 | 65.07 | 61.92(556) |
| PG &Above | 19.26 | 53.66 | 16.67 | 48.65 | 19.38 | 23.27(209) |
| Father Occupation | | | | | | |
| 3&4 NCO$^{\#}$ | 21.25 | 12.20 | 16.67 | 8.11 | 6.22 | 12.69(114) |
| 1&2 NCO$^{\#\#}$ | 34 | 36.58 | 41.67 | 40.54 | 23.92 | 30.07(270) |
| 1&2 NCO$^{\#\#}$ (Engineer) | 8.21 | 17.07 | 8.33 | 16.22 | 7.42 | 8.91(80) |
| Entrepreneur | 36.54 | 34.15 | 33.33 | 35.13 | 62.44 | 48.33(434) |
| Mother Occupation | | | | | | |
| House Wife | 65.44 | 29.27 | 58.33 | 31.08 | 70.09 | 63.03(566) |
| 3&4 NCO$^{\#}$ | 14.16 | 19.51 | 0 | 12.16 | 10.53 | 12.36(111) |
| 1&2 NCO$^{\#\#}$ | 11.90 | 31.71 | 16.67 | 50 | 12.20 | 16.15(145) |
| Entrepreneur | 8.50 | 19.51 | 25 | 6.76 | 7.18 | 8.46(76) |
| FA Income | | | | | | |
| Less than 6 Lakh | 27.19 | 9.76 | 8.33 | 9.46 | 18.9 | 20.82(187) |
| 6 to 12 lakhs | 28.61 | 4.88 | 25 | 4.05 | 23.45 | 23.05(207) |
| 12 to 18 lakhs | 25.50 | 53.66 | 50 | 29.73 | 39.71 | 34.08(306) |
| 18 lakhs Above | 18.70 | 31.70 | 16.67 | 56.76 | 17.94 | 22.05(198) |
| Total Share | 39.31(353) | 4.56 (41) | 1.34(12) | 8.24(74) | 46.55(418) | 100 (898) |

Source: Data estimation based on primary survey.

Notes:(i) 3 &4 NCO$^{\#}$, represents occupations classified under National Classification of Occupations (NCO) codes 3 and 4, these occupations such as: Librarians and Clerks of the University/College/School, Primary teachers, Nursing, Bank clerks, Technicians, Data entry Operators etc.

(ii) 1&2 NCO$^{\#\#}$, represents occupations classified under National Classification of Occupations (NCO) codes 1 and 2, these occupations such as: Lecturers/professors, Army and Navy Officers, Professionals, Legislators, Senior managers, Ministry, Doctors, Bank managers, Income-tax Officers, Railway jobs, Airport authority etc.

Furthermore, table 4.4 indicates that there is a positive relationship between the educational attainment of fathers and their children's enrolment to engineering education. For instance, among students whose fathers completed secondary education, merely 8.35% students pursued engineering education. This percentage increased to 44.54% for students whose fathers

completed graduation and further rose to 47.11% for those whose fathers attained post-graduate education or above. In the case of mothers' education, almost 85% of the total respondents are either graduates or postgraduates and above. When discussed individually by religion, the highest proportion of mothers with graduate and postgraduate degrees is from the Jain religion (97.30%), followed by Buddhists (91.67%), Christians (90.24%), and Sikhs (84.45%). Conversely, the lowest share of mothers with graduate, postgraduate, and above degrees is among Muslims (82.72%). The above findings suggest that parent's education may encourage children to enrol in engineering education, as there is an increase in students' enrolment in engineering education with an increase in parent's education level. Thus, high educational qualification of parents helps students to enter higher education including engineering and technical education (Pearson & Miller, 2012).

In terms of occupation of parents, nearly 10% of the respondents' fathers are engineers, which is very less in case of mothers (37 in number). However, 16% of the mothers are in the 1&2 NCO job category, which may include officers/managers, and this is almost two-fifths in the case of fathers. Furthermore, 48.33% of students have fathers who are entrepreneurs, exhibiting the highest proportion, and 12.69% whose fathers are from the 3 and 4 NCO job category. In the case of mothers, these percentages are 8.46% and 12.36%, respectively. Almost two-thirds of total mothers are housewives here, which is similar to the proportion among respondents of SC, ST, and OBC (62.36%). If we discuss it by religion, the situation is more or less the same for Muslims, Buddhists, and Sikhs, with around 65.44%, 58.33% and 70.09% of mothers being housewives, respectively. However, for Christian and Jain mothers, the proportion of housewives is notably lower, at around 30%. This indicates a greater preference for engineering education among students whose fathers are involved in entrepreneurial activities and in the 1&2 NCO job category. This also indicates that mothers' occupation may not be closely related to their children's enrolment in engineering education, especially considering that the majority of students across all religious groups have housewives as mothers. However, some notable exceptions have been observed among Christian and Jain students. Mothers of Christian and Jain respondents in occupation 1 and 2 NCO category constitute 31.71% and 50% respectively, which is the highest compared to other categories. It suggests that parental occupation may also help students access engineering education.

Here, almost two-fifths of the respondents' family income falls within the range of 12-18 lakhs per annum. Meanwhile, for respondents from SC, ST, and OBC categories, almost 50% had

family incomes of up to 12 lakhs per annum, with more than one-fifth having less than 6 lakhs per annum. When discussed by religion, more than half (55.80%) of Muslim respondents reported a family income of up to 12 lakhs, while the corresponding percentages for Christian, Buddhist, Jain, and Sikh respondents were 14.64%, 33.33%, 13.51%, and 42.35% respectively. The share of Muslim students belonging to families with annual incomes of less than Rs 6 lakh, around 30%, which is much higher compared to other minority groups, indicating a lower family annual income for this income group. It indicates a higher representation of this group in the lowest income range. Here, it has to be remembered that there are two institutions established for the Muslim community, i.e., JMI and JH, and one for Sikhs, i.e., GTBIT. On the other hand, for the other minority groups, the proportion has increased with the increase in family annual income levels, with the majority of students belonging to families with an income range of 12-18 lakhs. This implies that annual income of the family may help children to enter engineering education. Also, the findings of this study support the often-given statement that engineering education is a profession predominantly pursued by the upper middle class (Khatsrinova, et.al.,2020).

### 4.3.3. Socio-demographic and economic status of respondents classified by gender

Out of the total sample size of 3186 engineering students, 2288 belong to socially backward castes (SC, ST and OBC), and 898 are from minority groups. The data highlights a notable gender gap in the sample, with males comprising the majority 2537 students, constituting around 79.37%, and females account for 649 students, representing a smaller proportion around 20.37%. This gender inequality in participation suggests deep-rooted social stereotypes and biases associated with engineering education where females are discouraged to pursue engineering careers (Powell *et al*., 2009; Dasgupta & Stout, 2014; Solnik, 2017; Patterson et al., 2021). As discussed for SC, ST and OBC, gender wise classification of the respondents also reveals that maximum respondents (90.07% for male and 89.52% for female) are from the urban background. However, it is encouraging to see that 10.48% of the female respondents are from the rural background, in contrast to 9.93% of the urban respondents. In a society where traditionally, male children are given preference, more female respondents from the rural areas reveals a progressive picture. However, the share is still low and needs to be improved. The predominance of urban residents in the sample may indicate a trend of migration from rural to urban areas for educational or employment opportunities, a phenomenon commonly observed in many regions worldwide (Mitra, & Murayama, 2009).

Also, table 4.5 shows the distribution of students based on family type, categorized as joint and nuclear families, with separate figures for males and females from the total number of students. Among the total sample size, 11.35% of male students belong to joint families, whereas 13.56% of female students come from similar family structures. Conversely, the majority of students, constituting 88.65% of males and 86.44% of females, originate from nuclear families. Overall, the data here reflects a high proportion of nuclear families (88.20%) over joint families (11.35%) among students in the engineering field. It suggests that the students from nuclear families may experience greater support and resources to pursue higher education, including engineering (Parihar, et al., 2017; Bueno, et al., 2022).

It also presents the distribution of parents' education level among male and female students, along with the overall figures. The data on father's education level indicates that among male students, father of merely 8.44% of the respondents are secondary passed, 37.88% fathers are graduates, and 53.69% fathers have post-graduate degrees or above. On the other hand, among female students, fathers of 5.70% of the respondents are secondary passed, 40.22% fathers are graduates, and 54.08% fathers are with post-graduate degrees or above. Findings suggest that female students in engineering are from educated fathers as compared to their male counterparts. Overall, father of the majority of respondents, regardless of gender are PG degrees or above. In case of mother's education, for male sample, 24.36% are having PG and above degree, 60.67% mothers are graduates, 15.18% mothers are with secondary education. For female students, these percentages are 11.09%, 59.63%, and 29.28%, respectively. Findings suggest a positive correlation between parent's education level and their children's pursuit of engineering education, and this corroborates with previous studies (Ata-Aktürk, & Demircan, 2021; Craig, et al., 2021).

**Table-4.5: Gender wise socio-demographic and economic Status of students**

| Gender bifurcation of the total sample | Male | Female | Total |
|---|---|---|---|
| Residence | | | |
| Urban | 90.07 | 89.52 | 89.96 (2866) |
| Rural | 9.93 | 10.48 | 10.04 (320) |
| Family Type | | | |

| | | | |
|---|---|---|---|
| Joint | 11.35 | 13.56 | 11.35 (376) |
| Nuclear | 88.65 | 86.44 | 88.20 (2810) |
| Father Education | | | |
| Secondary | 8.44 | 5.70 | 7.88 (251) |
| Graduation | 37.88 | 40.22 | 38.36 (1222) |
| PG &Above | 53.69 | 54.08 | 53.77 (1713) |
| Mother Education | | | |
| Secondary | 15.18 | 11.09 | 14.34 (457) |
| Graduation | 60.67 | 59.63 | 60.30 (1921) |
| PG &Above | 24.36 | 29.28 | 25.36 (808) |
| Father Occupation | | | |
| 3&4 NCO$^{\#}$ | 16.32 | 13.71 | 15.79 (503) |
| 1&2 NCO$^{\#\#}$ | 36.22 | 38.67 | 36.72(1170) |
| 1&2 NCO$^{\#\#}$(Engineer) | 10.64 | 10.17 | 10.55 (336) |
| Entrepreneur | 36.82 | 37.44 | 36.94(1177) |
| Mother Occupation | | | |
| House Wife | 62.79 | 60.25 | 62.27 (1984) |
| 3&4 NCO$^{\#}$ | 13.32 | 16.02 | 13.87 (442) |
| 1&2 NCO$^{\#\#}$ | 17.54 | 18.18 | 17.67 (563) |
| Entrepreneur | 6.35 | 5.55 | 6.18 (197) |
| FA Income | | | |
| Less than 6 Lakh | 22.27 | 22.50 | 22.32 (711) |
| 6 to 12 lakhs | 21.60 | 21.88 | 21.66 (690) |
| 12 to 18 lakhs | 33.03 | 30.35 | 32.49 (1035) |
| Above 18 lakhs | 23.10 | 25.27 | 23.54 (750) |
| Total Share | 2537(79.37) | 649(20.37) | 3186 |

Source: Data estimation based on primary survey.

Notes:(i) 3 &4 NCO$^{\#}$, represents occupations classified under National Classification of Occupations (NCO) codes 3 and 4, these occupations such as: Librarians and Clerks of the University/College/School, Primary teachers, Nursing, Bank clerks, Technicians, Data entry Operators etc.

(ii) 1&2 NCO$^{\#\#}$, represents occupations classified under National Classification of Occupations (NCO) codes 1 and 2, these occupations such as: Lecturers/professors, Army and Navy Officers, Professionals, Legislators, Senior managers, Ministry, Doctors, Bank managers, Income-tax Officers, Railway jobs, Airport authority etc.

Parents occupation have also significant impact on the children education (Plasman, et al., 2021). Almost 85% of fathers of the respondents are officer or entrepreneur. However, mothers of the one fourth respondents are from this occupation. For male respondents, 62.79% mothers are housewives while this figure is 60.25% for female students. Overall, more engineering students are from rich household i.e. 12 to 18 lakh and more than 18 lakh groups. This could be attributed to the relatively stable financial status of families to send their wards to engineering education as they can provide greater access to educational resources and opportunities for their children, including enrolment in engineering education. Almost similar share of male and female students is from first two income groups i.e. less than 6 lakh and 6 to 12 lakh per annum. However, the gender gap in family income is found in two other income categories (12 to 18 lakh and more than 18 lakh). More male students in engineering education are from rich households as compared to female students.

## 4.4 To Sum up the Chapter

To sum up, this chapter gives a detailed discussion on reservation policies in enrolment and additional affirmative programs implemented by engineering institutions in Delhi. These initiatives aim to enhance the equitable access to engineering education, improving quality of teaching and educational outcomes of students from socially and economically marginalized groups. The socio-demographic and economic characteristics of students are also discussed in this chapter. Factors considered in the discussion are location of the residence, family type, parental education, occupation, and family income. The discussion has been made for two exclusively different groups of SC, ST, OBC as well as religious minorities. The difference in the socio-demographic and economic have also been made gender wise. The discussion highlights the influence of family and economic factors on educational pursuits, suggesting that urban families may have better access to information and resources for higher education as compared to rural households. Furthermore, the importance of parental education, occupation, and family's income in determining enrolment in engineering education is emphasized. The discussion suggests a significant gender gap in participation in engineering education in Delhi. The share of women in engineering education is less than their men counterparts, which is also found in several other studies in the literature (Singh, N. 2007; Gupta,2012; Yadav, & Singh, 2020; Melak and Singh,2021; Rashmi, et.al., 2022).

# CHAPTER-5

# INFERENTIAL ANALYSIS (Objective-3, 4 and 5)

## 5.1. Background

In the fourth chapter, objectives 1 and 2 have been discussed through qualitative analysis. The first objective discusses the reservation policies and other affirmative actions implemented by engineering institutions in Delhi. The second objective examines the socio-demographic and economic profiles of students belonging to socially backward castes (SC, ST and OBC), and religious minorities using descriptive statistics, also, it discusses gender-wise profiles within these groups.

In this chapter, Objectives 3, 4, and 5 are examined using inferential statistics. The primary focuses of these three objectives are to analyse and compare the academic performance, placement, and earnings of different student groups. Inferential statistics are utilised to draw conclusions about the population.

## 5.2. Objective-3: To analyse and compare the academic performance, placement and earnings among SC, ST and OBC engineering students.

In this objective, the study first identifies the factors affecting academic performance, as well as examines differences in academic performance among SC, ST and OBC engineering students. Next, it investigates the factors determining placement and earnings, and explores differences in the engineering labour market (placement and earnings) between these student groups.

This objective has been discussed in three part i.e. 5.2.1, 5.2.2 and 5.2.3 as below. Detail about this objective has been discussed in section 3.5 in chapter-3:

### 5.2.1 Academic Performance of SC, ST and OBC Students

$H_{11}$ = Managemen of the institution, Gender, Caste, Fath_Edu., Moth_Edu., Fath_Occu., Moth_Occu., FA_Income, Scholarship, Accommodation, Senior_Sec-Per, Senior_Sec_Med, independent variables taken in the analysis of academic performances of SC, ST and OBC students are significantly affecting the dependent variable "CGPA_of _Grad.". $\beta i \neq 0$ [ where $\beta i$= 1,2,3,4,5,6,7,8,9,10,11,12]

$H_{21}$ = There is a significant difference in the academic performance between OBC and SC, ST engineering students.

In this section, the Ordinary Least Squares (OLS) regression method has been run to analyse the factors affecting the academic performance of students from socially backward castes (SC, ST, and OBC), and to examine the differences between these student groups. The Cumulative Grade Point Average (CGPA) of graduates has been taken as the dependent variable in the regression equation, reflecting the overall academic performance of the students. The independent variables considered in the analysis, which may affect the dependent variable (CGPA of graduates), encompass Management of the institution, Gender, Caste, Father's Education, Mother's Education, Father's Occupation, Mother's Occupation, Family Annual Income, Scholarship, Accommodation, Senior Secondary Percentage, and Senior Secondary Medium (Ref- Page No.80, equation-2). Through the examination of these variables, the study aims to elucidate the factors that significantly affecting the academic performance of socially backward caste students (SC, ST and OBC).

As per the OLS estimations, the academic performance (CGPA) of engineering graduates is affected by management type of the institution, i.e. government or private. Remarkably, the overall findings reveal that graduates of private institutions exhibited a 20% higher chance of achieving a good percentage of marks compared to graduates of government institutions, at the one percent level of statistical significance. This finding agrees that even private colleges/institutions in India offer better quality education and produce successful graduates. However, it stands in contrast to the results of a study conducted by Ali *et al.* (2020), which reported different outcomes.

Moreover, the analysis reveals that several social and personal factors significantly influence the academic performance of engineering graduates. Gender and caste, along with parental

education, employment status, and family income, demonstrate significant relations with academic outcomes. Similarly, students' past academic backgrounds, including senior secondary percentage and medium of study, as well as the availability of scholarships, significantly impact academic performance (Table-5.1). However, provision of on-campus accommodation (hostel) facilities is positively correlated with academic performance, but it does not demonstrate statistical significance.

Thus, the OLS estimation rejects hypothesis $H_{10}$.

**Table -5.1: OLS Estimates by Caste, Dependent variable - CGPA of Graduates**

| Explanatory Variable | Overall | SC/ST | OBC |
|---|---|---|---|
| | Coeff. | Coeff. | Coeff. |
| Management | - 0.20***(0.041) | - 0.182***(0.047) | - 0.239***(0.084) |
| Gender | 0.16***(0.042) | 0.163***(0.057) | 0.171***(0.065) |
| Caste (SC/ST) | | | |
| OBC | 0.38***(0.034) | …… | ……. |
| Fath_Edu (Secondary) | | | |
| Graduation | 0.20***(0.076) | 0.337***(0.92) | 0.045(0.136) |
| PG and above | 0.418***(0.089) | 0.514***(0.111) | 0.212*(0.152) |
| Moth_Edu (secondary) | | | |
| Graduation | 0.175***(0.06) | 0.142**(0.073) | 0.232**(0.103) |
| PG and Above | 0.295***(0.086) | 0.262***(0.114) | 0.34***(0.137) |
| Fath_Occu (3&4$NCO^{\#}$) | | | |
| 1&2$NCO^{\#\#}$ | 0.372***(0.069) | 0.306***(0.092) | 0.432***(0.106) |
| 1&2NCO (Engineer) | 0.33***(0.081) | 0.334***(0.107) | 0.351***(0.125) |
| Entrepreneur | 0.132**(0.057) | 0.129*(0.074) | 0.122*(0.09) |
| Moth_Occu (Housewife) | | | |
| 3&4 $NCO^{\#}$ | 0.15**(0.072) | 0.178**(0.094) | 0.126(0.112) |
| 1&2$NCO^{\#\#}$ | 0.28**(0.09) | 0.288**(0.133) | 0.271**(0.129) |
| Entrepreneur | 0.038(0.085) | 0.02(0.108) | 0.094(0.142) |
| FA_Income (less than 6 lakh) | | | |
| 6 to 12 lakhs | -0.275***(0.082) | - 0.253***(0.101) | - 0.321**(0.142) |
| 12 to 18 lakhs | - 0.357***(0.104) | - 0.329***(0.131) | - 0.404***(0.172) |
| 18 lakhs Above | - 0.372***(0.14) | - 0.312*(0.191) | - 0.483**(0.22) |
| Scholarship | 0.32***(0.076) | 0.394***(0.092) | 0.19*(0.134) |
| Accommodation | 0.043(0.037) | 0.032(0.052) | 0.05(0.054) |
| Senior_Sec-Per (90% Above) | | | |
| 80-90% | -0.555***(0.045) | -0.423***(0.069) | - 0.645***(0.062) |
| 70-80% | -1.136***(0.053) | -0.967***(0.074) | -1.284***(0.079) |
| Below 70% | -1.799***(0.065) | - 1.621***(0.086) | - 1.961***(0.108) |

| | | | |
|---|---|---|---|
| Senior_Sec_Med | 0.448***(0.062) | 0.423***(0.072) | 0.564***(0.12) |
| Constant | 5.892***(0.139) | 6.046***(0.165) | 6.873***(0.241) |
| Adjusted R-squared | 0.5061 | 0.4410 | 0.4728 |
| Observations | 2288 | 1210 | 1078 |

Source: Data estimation based on primary survey.

Notes: (i) Statistical significance level: ***p < 0.01, **p < 0.05, * p < 0.1

(ii) 1&2 NCO$^{\#\#}$, represents occupations classified under National Classification of Occupations (NCO) codes 1 and 2, these occupations such as: Lecturers/professors, Army and Navy Officers, Professionals, Legislators, Senior managers, Ministry, Doctors, Bank managers, Income-tax Officers, Railway jobs, Airport authority etc.

(iii) 3 &4 NCO$^{\#}$, represents occupations classified under National Classification of Occupations (NCO) codes 3 and 4, these occupations such as: Librarians and Clerks of the University/College/School, Primary teachers, Nursing, Bank clerks, Technicians, Data entry Operators etc.

Upon examining the impact of institutional management on the academic performance of SC/ST and OBC students separately, it was found that SC/ST and OBC graduates from private institutions exhibited 18.2% and 23.9% higher chances, respectively, of achieving good marks than their counterparts from government institutions. Notably, the influence of institutional type on academic performance was more pronounced among OBC students compared to SC/ST students. Also, the analysis revealed a gender disparity in academic performance among engineering graduates from socially backward castes. Overall, male students demonstrated a 16% higher chance of achieving better academic performance than their female counterparts. When disaggregated by SC/ST and OBC students, the findings indicated that males had a 16.3% higher chance of scoring good marks compared to females in the SC/ST category and a 17.1% higher chance in the OBC category. These findings align with previous research suggesting that women across all categories face discrimination in academic performance compared to their male counterparts (Mamo *et al.*,2017; Kyere *et al.*, 2023).

Next, the OLS estimation in Table 5.1 shows that students from the OBC caste exhibit relatively better academic excellence than the students from SC/ST at one percent level of statistically significant. Specifically, the coefficient indicates that OBC students had 38% higher chances of achieving good percentages of marks compare to SC/ST students. This finding highlights the disparity in academic outcomes between these caste groups, with SC/ST students showing poorer performance relative to their OBC counterparts. Several factors contribute to this difference, including institutional factors such as choice of institution, socio-economic factors, parental education and occupation, and past academic achievements, along with the availability

of scholarships. Additionally, stereotypes and biases also play a significant role in influencing educational opportunities and outcomes for SC/ST students, as evidenced in previous research (Malhotra & Shekhar, 2013; Lynch, 2016; Arora and Singh, 2017; Narwana & Gill, 2020). Based on the above finding, it is evident that there is a significant difference in academic performance between these student groups.

Hence, hypothesis $H_{20}$ is rejected.

In this context, the findings reveal a positive and significant relationship between parents' education levels and the academic performance of engineering graduates within these groups. As the educational attainment of parents increases, there is an observed increase in the chance of achieving higher marks of graduates. Similarly, the occupational status of parents also positively influences academic performance, particularly among graduates whose parents belong to the 1& 2 NCO occupation categories. However, family annual income demonstrates a negative impact on the academic performance (CGPA) of engineering graduates from socially backward castes. This contradicts the notion that higher parental income directly correlates with improved academic performance, suggesting that other factors may be at place (Ali *et al.*, 2013; Finch, and Finch, 2022).

The availability of scholarships has been found to positively influence the academic performance of engineering graduates from socially backward castes at one percent level of statistically significant. Students who receive scholarships during their graduation demonstrate a 32% higher chance of achieving good grades compared to those without scholarships. Further analysis reveals that SC/ST students who receive scholarships exhibit a 39.4% higher probability of scoring good marks, while OBC students show a 19% higher chance. This suggests that scholarships contribute to improved academic outcomes, particularly among SC/ST students. Scholarships provide financial support, alleviate educational expenses, and enable students to focus on their studies without financial constraints. Additionally, it serves as a motivating factor, encouraging students to strive for excellence. Overall, scholarships play a crucial role in supporting and enhancing the academic performance of engineering graduates from socially backward castes (Ononye, and Bong, 2018; Cismaru, *et al.*, 2022; Berlanga, *et al.*, 2022). While the provision of accommodation (hostel) for students shows a positive relationship with the academic performance of engineering graduates, it does not demonstrate statistical significance. The overall coefficient suggests that students residing in hostels had a 4.3% higher chance of obtaining good marks compared to non-hostellers.

The study revealed a strong and significant relationship between students' high scores in senior secondary level examinations and their academic success at graduation level. Additionally, students who opted English as the medium of instruction during their senior secondary education exhibited 44.8% higher chances of attaining good marks in graduation compared to their counterparts who studied in another medium like Hindi. This finding aligns with previous literature, emphasizing the pivotal role of academic performance in schooling and the medium of instruction in determining students' institutional outcomes (Alam *et al*., 2014; Olufemi *et al.*, 2018).

### 5.2.2. Placement Outcomes of SC, ST and OBC students

$H_{31}$ = Management of the institution, Gender, Caste, Senior_Sec_Per, Senior_Sec_Med, CGPA_ of _Grad., independent variables taken in the analysis of placement of SC, ST and OBC students are significantly affecting the dependent variable "Placement" of engineering students. $\beta i \neq 0$ [ where $\beta i$= 1,2,3,4,5,6]

$H_{41}$ = There is a significant difference in the placement between OBC and SC, ST engineering students.

The placement outcomes of SC, ST and OBC students are analysed with the decision to get placement (whether students got placement or not) as the dependent variable. The independent variables include Management of the institution, Gender, Caste, Senior Secondary Percentage, Senior Secondary Medium, and CGPA of graduates, as detailed in Chapter 3 (Ref- Page No. 83, Equation-7). The estimation conducted using the probit model as the first stage equation of the Heckman selection model. The results showed that all independent variables taken in determining the placement are statistically significant (Table-5.2), which is discussed below with the coefficient value.

Therefore, hypothesis $H_{30}$ is rejected.

The results in Table 5.2 show that graduates from government institutions were 7.5% less likely to receive placement offers than their counterparts from private institutions, which was significant at the one percent level. This finding contradicts the study conducted by Choudhury

(2015), which reported a higher employment rate among graduates from government engineering institutions compared to those from private ones.

**Table -5.2**: P**lacement and earnings of SC, ST and OBC engineering graduates: Heckman selection model**

| | Stage 1: Factors affecting Placement | | | Stage 2: Factors affecting Earnings | | |
|---|---|---|---|---|---|---|
| Explanatory Variable | Overall | SCs/STs | OBCs | Overall | SCs/STs | OBCs |
| | AME | AME | AME | Coeffi. | Coeffi | Coeffi. |
| Management | -0.075***(0.021) | -0.083***(0.025) | - 0.044*(0.040) | 0.31***(0.028) | 0.321***(0.038) | 0.261***(0.073) |
| Gender | - 0.02*(0.021) | - 0.02*(0.028) | - 0.06**(0.031) | 0.071***(0.026) | 0.02(0.041) | 0.14***(0.056) |
| Caste (SC/ST) | | | | | | |
| OBCS | 0.023*(0.018) | …… | …… | 0.10***(0.023) | …… | …… |
| Senior_Sec_Per (90% Above) | | | | | | |
| 80-90% | - 0.08***(0.027) | - 0.10*(0.041) | -0.103***(0.034) | …… | …… | …… |
| 70-80% | - 0.20***(0.033) | -0.162***(0.046) | -0.236***(0.047) | …… | …… | …… |
| Less than 70% | -0.19***(0.044) | -0.153***(0.059) | -0.203***(0.071) | …… | …… | …… |
| Senior_Sec_Med | 0.061**(0.031) | 0.063*(0.038) | 0.05(0.058) | …… | …… | …… |
| CGPA_ of _Grad. | 0.20***(0.008) | 0.223***(0.012) | 0.18***(0.012) | 0.181***(0.034) | 0.10*(0.062) | 0.163***(0.062) |
| Lambda | -0.42***(0.070) | -0.452***(0.114) | -0.606***(0.145) | …… | …… | …… |
| Constant | -4.43***(0.310) | -5.008***(0.440) | -3.725***(0.498) | 11.863***(0.276) | 12.55***(0.501) | 12.161***(0.517) |
| Prob.>$Chi^2$ | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Observations | 2288 | 1210 | 1078 | 2288 | 1210 | 1078 |

Source: Data estimation based on primary survey
Notes: (i) Statistical significance level: ***p < 0.01, **p < 0.05, * p < 0.1 (ii) AME; Average marginal effect.

When examining specific categories, SC/ST graduates from government institutions had an 8.3% lower probability of receiving placement offers compared to their peers from private institutions, while OBC graduates exhibited a 4.4% lower likelihood. These findings indicate a deviation from the expected pattern, with SC/ST graduates from government institutions being more adversely affected. The employment landscape within the engineering sector reflects caste-based disparities, with students from lower social castes (SC/ST) having 2.3 per cent less

chances of securing placements than their counterparts from Other Backward Classes such as the OBC category. Although this percentage appears relatively small, it still highlights the persistence of discrimination within these groups. These findings support previous research, such as the study conducted by Kumar and Hashmi (2020), which highlights the increasing discrimination faced by SC/ST students in the job market. As a result, it is evident that there is indeed a statistically significant difference in placement between these groups.

Accordingly, hypothesis $H_{40}$ is rejected.

Furthermore, the analysis highlights the significant effect of two key factors related to previous academic background on placement outcomes. These factors include the medium of study and the percentage of marks obtained at the senior secondary level. The findings show that students who had obtained a higher percentage in senior secondary education are more likely to get placements than the students who had obtained a lower percentage. The result also reveals that students who have studied in English medium schools as opposed to other medium schools have higher chances of getting a job. This observation aligns with the common belief that candidates from English-medium backgrounds perhaps perform better in placement processes like interviews, thereby enhancing their placement prospects.

Again, the analysis outlines the positive and highly significant relationship between students' overall cumulative grade point average (CGPA) at the graduation level and their chances of getting placement. The CGPA emerges as a pivotal determinant of placement outcomes, demonstrating statistical significance at the one percent level. These findings support with the prior research that emphasizes the important role of human capital factors in reducing employment disparities (Stephan, 1996; Laskowska and Dańska-Borsiak, 2016).

### 5.2.3 Earnings Status of SC/ST and OBC Students

$H_{51}$ = Management of the institution, Gender, Caste, CGPA_ of _Grad., independent variables taken in the analysis of earnings of SC, ST and OBC students are significantly affecting the dependent variable “annual earnings” of engineering students, $\beta i \neq 0$ [where $\beta i = 1,2,3,4$]

$H_{61}$ = There is a significant difference in the earnings between OBC and SC, ST engineering students.

The study employs a regression model as the second stage equation of the Heckman selection model to determine the factors influencing the earnings of SC, ST, and OBC students. The regression equation considers the annual earnings of engineering graduates in logarithmic form as the dependent variable. The independent variables encompass management, caste, gender, and CGPA of engineering graduates, as detailed in Chapter 3 (Ref- page no.83, equation 8). Here, the overall regression result shows that all the independent variables taken for analysis significantly affect the earnings of students at one percent level of statistical significance (Table-5.2). The variables are discussed below with corresponding coefficient values.

Consequently, hypothesis $H_{50}$ is rejected.

The OLS estimation reveals significant caste-based disparities in earnings among these groups, with engineering graduates from lower social castes (SC/ST) earning 10% less than their OBC counterparts. Thus, the societal categorisation of students plays an important role in determining the earnings from placements. This finding is consistent with previous research, which outlines the prevalence of wage discrimination against SC/ST workers in the Indian job market. The research highlights social factors such as gender and caste category, and institutional management as well as academic performance of students, that contribute to these disparities. As well, studies have suggested the need to address such disparities and promote opportunities for wage equality (Gupta and Kothe, 2022; Singh, 2023).

Thus, the estimation rejected hypothesis $H_{60}$.

Additionally, within these student groups, gender disparity in earnings is evident, with male engineers earning on average about 7% more than their female counterparts. Upon further examination within the SC/ST and OBC categories, male engineers within the SC/ST group earn about 2% more than their female counterparts, while male engineers within the OBC category earn approximately 14% more than their female counterparts. This discrepancy highlights a notable gender wage gap, particularly pronounced within the OBC category. Such findings underscore the persistence of gender inequality in earnings within socially disadvantaged groups.

The management of institution emerges as a significant determinant of the annual earnings from placement of engineering graduates. The overall regression results indicate that government engineering students earn approximately 31% more than their counterparts from private

institutions. Furthermore, SC/ST students from government institutions earn around 32% more, while OBC students from government institutions earn 26% more compared to students from private institutions. This may be due to potential preferential treatment for SC/ST students in government institutions, in which they receive better opportunities or benefits. Additionally, these findings align with the perception that government institutions in India produce graduates with higher levels of talent and knowledge compared to private institutions (Sudan, 2013; Vijayan, 2018; Kumar, 2018). Overall, the results underscore the importance of institutional management in determining earnings among engineering graduates.

The cumulative Grade Point Average (CGPA) of engineering graduates is a significant determinant of higher salaries, indicating that students with higher academic performance tend to earn more, while students with poorer academic records experience lower earnings. This underscores the crucial role of academic achievement in shaping future career prospects and income levels. In conclusion, the estimations emphasize the influence of social caste categories, the presence of gender disparities, the impact of institutional management, and the importance of academic performance in shaping salary outcomes among engineering graduates. Addressing these factors is essential for fostering a more equitable and inclusive engineering labour market.

## 5.3. Objective-4: To analyse and compare the academic performance, placement and earnings among religious minority students

In this objective, the study 1st identifies the factors affecting academic performance, as well as observes differences in academic performance among minority students. Then, it investigates the factors determining placement and earnings, and explores differences in the engineering labour market (placement and earnings) between these student groups.

This objective has also been discussed in three part i.e. 5.3.1, 5.3.2, and 5.3.3 as below. Detail about this objective has been discussed in section 3.5 in chapter-3. Additionally, include a section (i.e., 5.3.4) on the status of minorities in specialized institutions and other institutions, noting that Delhi has three institutions exclusively for religious minority candidates.

### 5.3.1 Academic Performance (CGPA) of Minority Students

$H_{71}$ = Management of the institution, Gender, Religion, Fath_Edu., Moth_Edu., Fath_Occu., Moth_Occu., FA_Income, Senior_Sec-Per, Senior_Sec_Med, independent variables taken in the analysis of academic performances of minority students are significantly affecting the dependent variable "CGPA_of_Grad.". $\beta i \neq 0$ [ where $\beta i = 1,2,3,4,5,6,7,8,9,10$].

$H_{81}$ = There is a significant difference in the academic performance among Muslims and other minority engineering students.

The primary objective of this section is to investigate the factors affecting the academic performance of students from religious minority groups, and to explore differences in academic outcomes among these groups. The OLS regression method is utilised to estimate the results, and here the overall cumulative grade point average (CGPA) obtained by minority students has been taken as the dependent variable. Independent variables include Management, Gender, Religion, parental education and occupation, Family Annual Income, Senior Secondary Percentage, and Senior Secondary Medium. The regression equation, and detailed descriptions of these variables are provided in Chapter 3 (Ref- Equation 3, and Table-3.2). By analysing these factors through OLS technique, it is evident that all the considered independent variables, except gender, significantly influence the academic performance of minority students in engineering education (Table 5.3). The significant variables are outlined below along with the respective coefficient values.

Consequently, hypothesis $H_{70}$ is rejected.

**Table –5.3: OLS Estimates by Religion, Dependent variable - CGPA of Graduates**

| Explanatory Variable | Overall | Muslims | Other minorities |
|---|---|---|---|
| | Coeff. | Coeff. | Coeff. |
| Management | 0.258***(0.087) | 0.427**(0.196) | 0.163*(0.112) |
| Gender | -0.011(0.068) | - 0.115(0.119) | 0.043(0.084) |
| Religion | 0.727***(0.077) | ……. | …… |
| Fath_Edu (Secondary) Graduation | 0.304***(0.13) | 0.178(0.192) | 0.403**(0.186) |

| | | | |
|---|---|---|---|
| PG and Above | 0.414***(0.152) | 0.433*(0.246) | 0.442**(0.207) |
| Moth_Edu (secondary) | | | |
| Graduation | 0.304***(0.103) | 0.318**(0.163) | 0.311***(0.133) |
| PG and Above | 0.602***(0.156) | 0.533**(0.261) | 0.642***(0.197) |
| Fath_Occu (3&4 $NCO^{\#}$) | | | |
| 1&2 $NCO^{\#\#}$ | 0.138(0.125) | 0.536***(0.190) | - 0.076(0.189) |
| 1&2 NCO (Engineer) | 0.263*(0.147) | 0.370*(0.223) | 0.218(0.214) |
| Entrepreneur | 0.09(0.107) | 0.247*(0.161) | - 0.041(0.164) |
| Moth_Occu (Housewife) | | | |
| 3&4 $NCO^{\#}$ | 0.109(0.144) | 0.451**(0.223) | - 0.086(0.194) |
| 1&2 $NCO^{\#\#}$ | 0.344**(0.159) | 0.895***(0.252) | 0.07(0.207) |
| Entrepreneur | - 0.014(0.121) | 0.157(0.209) | - 0.038(0.154) |
| FA_Income (less than 6 lakh) | | | |
| 6 to 12 lakhs | - 0.394***(0.09) | - 0.723***(0.137) | - 0.218*(0.126) |
| 12 to 18 lakhs | - 0.494***(0.111) | - 0.934***(0.196) | - 0.336***(0.138) |
| 18 lakhs Above | - 0.777***(0.194) | - 1.426***(0.334) | - 0.498**(0.244) |
| Senior_Sec_Per | - 0.782***(0.069) | - 0.558***(0.097) | - 0.955***(0.10) |
| Senior_Sec_Med | 0.542***(0.127) | 0.455***(0.169) | 0.649***(0.197) |
| Constant | 5.707***(0.199) | 5.665***(0.294) | 6.391***(0.286) |
| Adjusted R-squared | 0.3846 | 0.3093 | 0.3866 |
| Observations | 898 | 353 | 545 |

Source: Data estimation based on primary survey.

Notes: (i) Statistical significance level: ***p < 0.01, **p < 0.05, * p < 0.1

(ii) 1&2 $NCO^{\#\#}$, represents occupations classified under National Classification of Occupations (NCO) codes 1 and 2, these occupations such as: Lecturers/professors, Army and Navy Officers, Professionals, Legislators, Senior managers, Ministry, Doctors, Bank managers, Income-tax Officers, Railway jobs, Airport authority etc.

(iii) 3 &4 $NCO^{\#}$, represents occupations classified under National Classification of Occupations (NCO) codes 3 and 4, these occupations such as: Librarians and Clerks of the University/College/School, Primary teachers, Nursing, Bank clerks, Technicians, Data entry Operators etc.

The institutional factor "management of institutions" significantly affects the cumulative grade point average (CGPA) of minority engineering graduates at one percent level of statistical significance. The overall coefficient shows that graduates of government institutions have a 25.8% more chance of scoring good percentage of marks than graduates of private institutions. When examining Muslims and other minority groups separately, the coefficient reveals that graduates from government institutions, particularly Muslims, have a 42.7% higher likelihood of obtaining good percentages than those from private institutions. Similarly, graduates from other minority groups (Sikh, Jain, Buddhist, and Christian) exhibit a 16.3% higher chance of scoring well in their academic performance when attending government institutions compared

to private ones. Here, the impact of government institution on students' academic performance is greater among Muslims than other minorities. This can be attributed to the quality education provided exclusively to Muslim students by two government minority institutions in Delhi namely JMI and JH, which may lead to higher academic performance (CGPA) of Muslim students in government institutions compared to others.

Also, there is a significant disparity among minorities in terms of overall academic performance, with students from other minority groups (Sikh, Jain, Buddhist, and Christian) demonstrating higher levels of academic excellence. In view of the fact that students from these groups had 72.7% more chance to scoring good percentage of marks as compare to Muslims. This clearly shows that the overall academic performance of Muslim students is lower than that of students from other minority groups. Some important factors that can be responsible for this are socio-economic conditions, education and occupation of parents, intermediate and high school educational background, etc. (Ali *et al.*, 2013; Arora and Singh 2017; Alabdulkarem *et al.*, 2021).

As per the above discussion, hypothesis $H_{80}$ is rejected.

In this context, the estimations indicate that parents' education significantly affects the academic performance of minority engineering graduates at the one percent level of statistically significant. The result shows that as the levels of parents' education increase, the chances of getting good marks of graduates also increases, and mothers' education applying a more pronounced impact on academic success of students. Similarly, parents' occupation also plays a significant and positive role, with fathers in engineering occupations and mothers in category 1&2 NCO occupations having the most significant influence on academic achievements of students. Next, another related factor that is family annual income has a negative impact on the academic performance (CGPA) of minority engineering graduates at one percent level of statistically significant. The results show that students with high family income scored lower percentage of marks in engineering education. This finding does not support the concept that the higher economic status of father/guardian positively contributes to the academic performance of students, suggesting that high-income parents do not necessarily lead to higher test scores for students (Ali et al., 2013).

Subsequently, the estimates found that students who secured higher percentage of marks in senior secondary examination have obtained good grades/marks in their graduation level.

Likewise, students who have opted English medium at senior secondary level had a 54.2% more chance of scoring good marks in graduation compared to students of other mediums like Hindi. These findings support the general impression that the schooling in English medium helps students to perform better at graduation level. The finding also agrees with the literature which emphasises that school related factors, such as academic achievement and medium of study in schooling are one of the most important factors for the students' good/bad institutional results (Mersha *et al.*, 2013; Alam *et al.*, 2014; Olufemi *et al.*, 2018).

### 5.3.2 Placement Outcomes of Minority Engineering Students

$H_{91}$ = Management of the institution, Gender, Religion, Senior_Sec_Per, Senior_Sec_Med, CGPA_ of _Grad., independent variables taken in the analysis of "placement" of minority students are significantly affecting the dependent variable "placement" of engineering students, $\beta i \neq 0$ [where $\beta i=1,2,3,4,5,6$].

$H_{101}$ = There is a significant difference in the placement among Muslims, and other Minorities.

Here, the study examines the factors influencing placement of students from religious minority groups, and to find out differences in placement outcomes between them. To analyse this, the placement decision of minority students (whether they received placement or not) serves as the dependent variable, while the independent variables include management, gender, religion, Senior Secondary Percentage, Senior Secondary Medium and CGPA of minority graduates. As discussed in Chapter-3 (Ref. Page No. 83, Equation-9), this is the first stage Heckman selection model for the placement outcomes of minority student groups, which is calculated by the probit model. By using this model, the study identifies the significant determinants of placement among minority students.

The results presented in Table 5.4 indicate that the social factor i.e. gender significantly influences the placement of minority graduates, as evidenced by its statistical significance at the one percent level. It yields some interesting findings that the female engineering graduates from minority communities have a 10.2% higher likelihood of receiving job offers compared to their male counterparts. Surprisingly, this effect is more pronounced among Muslim minority groups, suggesting a prioritization of females in the engineering labour market, likely due to their lower representation in the field. The findings may suggest that among the relatively few

females pursuing engineering, a higher proportion find employment in the field, leading to a higher placement ratio than males. Similarly, one more key social factor, that is religion of the students, as well as the previous educational background, current academic performance (CGPA) of the graduates are also statistically significant in determining the placements of minority students.

So, hypothesis $H_{90}$ is rejected

**Table -5.4: Placement and earnings of Minority engineering graduates: Heckman selection model**

| | Stage 1: Determinants of placement | | | Stage 2: Determinants of Earnings | | |
|---|---|---|---|---|---|---|
| Explanatory Variable | Overall | Muslims | Other Minorities | Overall | Muslims | Other Minorities |
| | AME | AME | AME | Coeffi. | Coeffi. | Coeffi. |
| Management | - 0.016(0.040) | 0.056(0.093) | -0.027(0.050) | 0.336***(0.034) | 0.12*(0.112) | 0.328***(0.039) |
| Gender | -0.102***(0.033) | -0.238***(0.056) | - 0.054*(0.038) | 0.10*(0.037) | 0.062(0.078) | 0.05*(0.041) |
| Religion | - 0.06*(0.038) | …….. | ……... | 0.27***(0.038) | ……. | ……. |
| Senior_Sec_Per. | - 0.10*(0.034) | - 0.06*(0.046) | -0.10*(0.050) | ……. | ……. | ……. |
| Senior_Sec_Med | 0.04(0.059) | 0.03(0.076) | 0.06(0.092) | ……. | ……. | ……. |
| CGPA_of_Grad. | 0.23***(0.012) | 0.237***(0.018) | 0.22***(0.017) | 0.25***(0.059) | 0.17***(0.071) | 0.406***(0.086) |
| Lambda | -0.20***(0.151) | -0.30***(0.167) | -0.20*(0.228) | …… | …… | …… |
| Constant | -4.422***(0.551) | -4.865***(0.839) | -4.725***(0.741) | 10.953***(0.465) | 12.068***(0.566) | 10.137***(0.742) |
| Prob.>$Chi^2$ | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Observations | 898 | 353 | 545 | 898 | 353 | 545 |

Source: Data estimation based on primary survey.
Notes: (i) Statistical significance level: ***p < 0.01, **p < 0.05, * p < 0.1 (ii) AME; Average marginal effect.

According to the estimates presented in Table 5.4, the factor "religion of the students" is statistically significant in determining the chances of obtaining placement. Interestingly, the results here found that Muslim engineering graduates are 6% more likely to get placements than other minority graduates. The better placement outcomes of Muslim students can be attributed to the good placement quality and productivity of the two minority engineering institutions (Jamia Millia Islamia and Jamia Hamdard) for Muslims from the government category in Delhi. In fact, in both these institutions, reservation or affirmative action programs are designed only for the Muslim students' education, resulting in increased participation of this demographic. As a result, a higher proportion of Muslim students enrolled in these colleges are likely to get placements, thereby leading to higher placement rates observed among Muslim engineering graduates in Delhi. However, when the placement status of Muslim students is examined excluding those attending these two colleges, their placement share appears remarkably lower than that of other minority student groups. This suggests that the observed disparity in placement rates is largely influenced by the intensive efforts and supportive measures implemented within these specific educational institutions, rather than being indicative of broader trends across all engineering institutions.

This finding agrees with the literature which discusses that the advancement of Muslim students in higher education largely depends on government institutions. It also suggests that downgraded Muslims may pursue higher studies and perform better in engineering field, if they receive assistance through scholarships, reservations, and other affirmative actions. For instance, in India, the proportion of Muslim students is relatively higher in certain central universities and government-aided deemed universities such as Maulana Azad National Urdu University (MANUU), Aligarh Muslim University (AMU), Jamia Millia Islamia (JMI) and Jamia Hamdard (JH). These universities give more priority to this group through seat reservations, scholarships, a differential fee structure, a suitable college/institute environment, hostel facilities, remedial coaching classes, and better training for placements in the job market, etc. (Bahri, 2016; Qamar and Shamra,2021; Thorat,2022).

Thus, hypothesis $H_{100}$ is rejected.

Moreover, the factors included under the past academic background of students, the percentage of marks at senior secondary level education is statistically significant in determining the chance of getting placement. The overall coefficient shows that the students who score a higher

percentage of marks at senior secondary level are more likely to get placement, but the effect of this variable is more marked among other minority student groups than among Muslim students. Then, inclusion of medium of study at senior secondary level as a variable was found to be statistically insignificant. In addition, the variable included under current educational background of students, CGPA of engineering graduates is statistically significant at one percent level. The result reveals that CGPA of engineering graduates is positively related to their placement outcomes, where the chances of placement increases with increase in cumulative grade point average (CGPA) of engineering graduates. However, the impact of graduates' CGPA appears to be slightly greater for Muslims than for other minority student groups. It is generally accepted that human capital variables are also important factors for the purpose of employment and play a positive role for productivity (Tuicu, and Simko, 2015).

### 5.3.3 Earnings Status of Minority Engineering Students

$H_{111}$ = Management of the institution, Gender, Religion, CGPA_ of _Grad., independent variables taken in the analysis of earnings of minority students are significantly affecting the dependent variable "annual earning" of students. $\beta i \neq 0$ [ where $\beta i$= 1,2,3,4].

$H_{121}$ = There is a significant difference in the earnings between Muslims and other minority students.

The study investigates the determinants of earnings among minority students by employing OLS regression as the second stage of the Heckman selection model for earnings of minority groups. The dependent variable is the annual earnings of minority graduates (In logarithmic form), and independent variables include Management, Gender, Religion, and CGPA of minority graduates (Ref- page no.83, Equation 10). As per the OLS estimation, the study found that all independent variables considered in the analysis significantly determine the earnings of minority engineering graduates (Table-5.4). Further details on these variables are given below.

Hence, hypothesis $H_{110}$ is rejected.

Here, OLS estimates confirm a significant religious gap in the earnings of engineering graduates, where earnings of Muslim engineering graduates are around 27% less than that of

all other minority graduates. This finding agrees with some other research which emphasises that discrimination is evident across the socio-religious incomes gap. In particular, Muslim employees earn less than other groups due to discrimination, and have also been found to be discriminated against in both the government and private sectors (Kundu, 2015; Chakraborty and Bohara, 2021). Another social factor "gender" has also been found to be statistically significant in determining the earnings of minority engineering students. The analysis confirms that among minorities, male engineering graduates have significantly higher earnings than female graduates. The overall coefficient reveals that male engineering graduates from minority backgrounds earn about 10% more than their female counterparts. Specifically, among Muslims and other minority groups, this earning gap is 6.2% and 5%, respectively. Similar results have been found in several other studies in India and elsewhere (Bhaumik and Chakrabarty,2009; Li and Miller,2012; Jong-Wha & Wie,2017).

The above findings rejected hypothesis $H_{120}$.

Also, institutional management (government/private) is an important determinant of earnings, which has statistical significance at the one percent level. The overall regression coefficient shows that the annual earnings of government engineering students are about 33.6% higher than that of private engineering students. Similarly, the coefficients for both Muslims and other minority student groups give similar type of outcomes, but with varying degrees. Muslim graduates from government institutions get 12% more salary than private institutions while for other minorities, the figure is 32.8%. This indicates that choice of institution matters more in respect of earnings of other minority student groups as compared to Muslims. Then, the variable "Cumulative Grade Point Average (CGPA) of graduates" shows a positive and significant relationship with higher earnings, the same trend was observed in the case of both Muslim and other minority engineering graduates. The results indicate that excellence in academic performance during graduation is directly associated to higher earnings, while lower performance is linked with lower earnings.

### 5.3.4. Minority Communities in Specialized Institutions and Non-specialized Institutions

As discussed earlier, there are three minority institutions in Delhi, namely JMI, JH (from government category) and GTBIT (Private institute) (Chapter-4, page no. 88.). Therefore, the study wanted to be discussed the difference in academic performance and labour market

outcomes among minority communities in specialized institutions and non-specialized institutions in Delhi, focusing on Muslim-majority institutions (JMI, JH) and the Sikh-majority institution (GTBIT). However, due to the small sample sizes, particularly in non-specialized institutions, the intended inferential statistical method could not be conducted effectively and analysis could not yield significant results, especially in analysing labour market status among students. Particularly in the case of earnings analysis, the sample size tends to be much smaller as the study only observed the earnings of those students who received placement offers. Instead, the study shifted its focus to discussing gender-based participation and the economic backgrounds of these minority groups across specialised and other institutions using descriptive statistics. To find out whether students from lower economic backgrounds are choosing their particular institution or their economic status does not influence institutional choices.

#### 5.3.4.1. Distribution of Muslim and Sikh Students in Specialized and Other Institutes

Here, the study included overall 898 respondents from religious minority groups, comprising 418 (46.55%) Sikhs, 353 (39.31%) Muslims, and 127 (14.14%) from other categories (Jain, Christian, and Buddhist). In particular, specialized institutions for Muslim and Sikh communities accounted for a higher number of respondents from these groups. Among Muslim students, 248 (70.25%) were from specialized institutes, and 105 (29.75%) were from other institutions. Similarly, among Sikh students, 328 (78.47%) were from specialized institutes, while 90 (21.53%) were from other institutions.

**Figure – 5.1 & 5.2: Distribution of Muslim and Sikh Students in Specialized and Other Institutes (Gender Wise)**



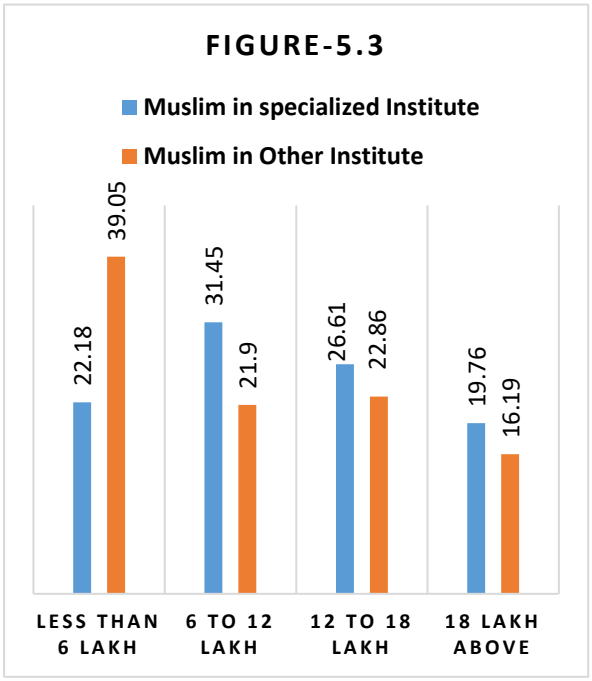
Source: students' questionnaire

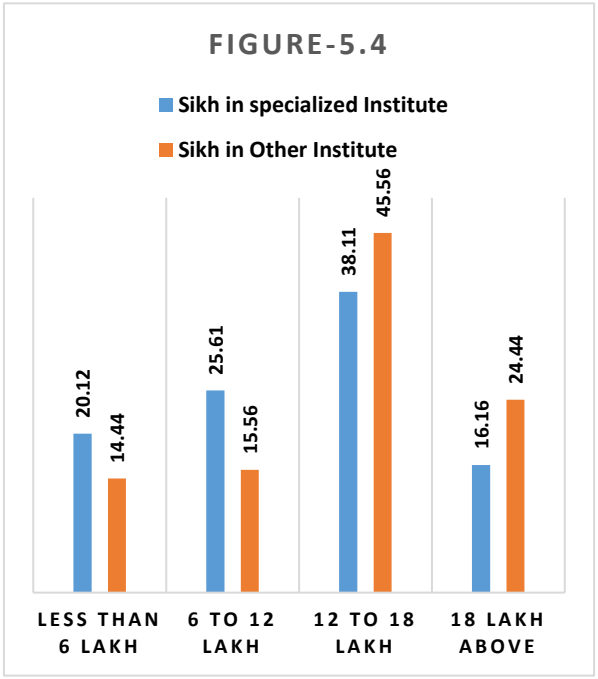
Note: (i) Muslim specified Institutions: Jamia Millia Islamia and Jamia Hamdard (Government Category)
(ii) Sikh specified Institution: Guru Tegh Bahadur Institute of Technology (Private Category)

Gender-wise distribution revealed that out of total Muslim students, 293 (83.00%) are males and 60 (17.00%) are females. Likewise, Sikh students were mostly male, with 320 (76.56%) males and 98 (23.44%) females. However, this shows that the overall participation of Sikh females is presenting a better picture than that of Muslim females. Both male and female students showed a higher presence in their respective specialized colleges compared to other colleges (Figure-5.1 & 5.2). This suggests that their participation increases overall due to specific institutions, while gender disparities persisted within these colleges as like other institutions, indicating discrimination. Excluding these specialized colleges highlighted a worse picture of participation for these groups in other institutes.

Next, we discuss the distribution of Muslim and Sikh students in specialized and other institutions by considering their economic background.

**Figure – 5.3 & 5.4: Economic backgrounds of Muslim and Sikh Students in Specialized and Other Institutions**




Source: students' questionnaire

Note: (i) Muslim specified Institutions: Jamia Millia Islamia and Jamia Hamdard (Government Category)
(ii) Sikh specified Institution: Guru Tegh Bahadur Institute of Technology (Private Category)

Family income plays an important role in institution enrolment. It is observed that about 61% of Muslim students whose family income is up to one lakh per month are studying in general colleges. Whereas the share of Muslim students in the same income group in colleges specified for Muslims is around 54%. Conversely, in the case of Sikh minority, around 46% of students with families earning up to one lakh per month are attending the specified institutions, while the figure is about 30% in other institutions. Here, the figure suggests a preference among economically advantaged Muslim students for exclusive institutions, potentially indicating easier access for wealthier individuals. In contrast, economically better-off Sikh students tend to enrol in general institutions.

## 5.4. Objective-5: To analyse and compare the academic performance, placement and earnings of female engineering students with their male counterparts.

In this objective, the study identifies the factors affecting academic performance of engineering students, as well as examines gender differences in academic performance. Also, it explores the factors determining placement and earnings, and examines gender differences in the engineering labour market (placement and earnings).

This objective discussion has been divided into three parts, i.e., 5.4.1, 5.4.2, and 5.4.3, as outlined below. Detail about this objective has been discussed in section 3.5 in chapter-3. Additionally, include a section (i.e., 5.4.4) on the status of women in specialized institutions and other institutions, as Delhi has a women's university exclusively for female candidates, highlighting the importance of gender-specific educational opportunities.

### 5.4.1 Academic Performance (CGPA) of Female Engineering Students

$H_{131}$ = Management of the institution, Gender, Religion, Caste, Fath_Edu., Moth_Edu., Fath_Occu. Moth_Occu., FA_Income, Senior_Sec-Per, Senior_Sec-Sch_Type, Senior_Sec_Med, independent variables taken in the analysis of academic performances of male and female students are significantly affecting the dependent variable "CGPA_of_Grad.", $\beta i \neq 0$ [ where $\beta i = 1,2,3,4,5,6,7,8,9,10,11,12$].

$H_{141}$ = There is a significant difference in the academic performance between male and female engineering students.

In this section, the study seeks to analyse the factors affecting the academic performance of engineering students as a whole, and explore the gender-based differences in academic achievement, using OLS technique. As outlined in Chapter-3 (Ref- page no.80, Equation-4), the dependent variable in the regression equation is the overall CGPA of engineering graduates. The independent variables under consideration include management, gender, religion, caste, parents' education and occupation, family annual income, senior secondary percentage, senior secondary school type and senior secondary medium.

The OLS estimation in Table 5.5 indicates that graduates from government institutions had a 12.5% lower likelihood of achieving a good percentage of marks compared to graduates from

private institutions, with statistical significance at the one percent level. This finding contradicts the common assumption that graduates of government institutions outperform those from private institutions. Additionally, other factors such as social variables (gender, caste, and religion), parental education and occupation, family annual income, and previous educational background also significantly influence the academic performance of students in engineering education, with statistical significance at the one percent level.

Therefore, hypothesis $H_{130}$ is rejected.

**Table -5.5: OLS regression by Gender, Dependent variable–CGPA of Graduates**

| Explanatory Variable | Total | Male | Female |
|---|---|---|---|
| | Coeff. | Coeff. | Coeff. |
| Management | -0.125***(0.038) | - 0.131***(0.043) | - 0.086(0.089) |
| Gender | 0.10***(0.034) | …….. | …… |
| Religion | | | |
| Muslim | - 0.26***(0.067) | - 0.28***(0.079) | - 0.105(0.136) |
| Sikh | 0.242***(0.071) | 0.264***(0.084) | 0.246*(0.136) |
| Others | 0.174***(0.089) | 0.194*(0.107) | 0.14(0.159) |
| Caste | | | |
| OBC | - 0.04(0.061) | - 0.012(0.074) | - 0.043(0.112) |
| SC | - 0.37***(0.065) | - 0.353***(0.077) | - 0.32***(0.124) |
| ST | - 0.47***(0.075) | - 0.455***(0.09) | - 0.43***(0.142) |
| Fath_Edu. (Secondary) | | | |
| Graduation | 0.23***(0.065) | 0.186***(0.72) | 0.453***(0.154) |
| PG and above | 0.405***(0.075) | 0.341***(0.084) | 0.712***(0.173) |
| Moth_Edu. (secondary) | | | |
| Graduation | 0.192***(0.051) | 0.208***(0.057) | 0.113(0.116) |
| PG and Above | 0.364***(0.073) | 0.40***(0.083) | 0.204*(0.161) |
| Fath_Occu. (3&4$NCO^{\#}$) | | | |
| 1&2 $NCO^{\#\#}$ | 0.351***(0.058) | 0.314***(0.066) | 0.491***(0.128) |
| 1&2 NCO (Engineer) | 0.38***(0.069) | 0.331***(0.077) | 0.58***(0.151) |
| Entrepreneur | 0.172***(0.049) | 0.156***(0.055) | 0.294***(0.112) |
| Moth_Occu. (House wife) | | | |
| 3&4 $NCO^{\#}$ | 0.15***(0.063) | 0.11*(0.071) | 0.28**(0.132) |
| 1&2 $NCO^{\#\#}$ | 0.29***(0.076) | 0.241***(0.088) | 0.401***(0.155) |
| Entrepreneur | 0.03(0.066) | 0.01(0.074) | 0.10(0.144) |
| FA_Income (less than 6 lakh) | | | |
| 6 to 12 lakhs | - 0.434***(0.045) | - 0.421***(0.051) | - 0.504***(0.096) |
| 12 to 18 lakhs | - 0.52***(0.058) | - 0.49***(0.066) | - 0.63***(0.123) |
| 18 lakhs Above | - 0.564***(0.096) | - 0.511***(0.112) | - 0.715***(0.195) |

| | | | |
|---|---|---|---|
| Senior_Sec_Per. (90% Above) | | | |
| 80-90% | - 0.611***(0.039) | -0.53***(0.044) | - 0.902***(0.081) |
| 70-80% | -1.15***(0.044) | -1.1***(0.05) | -1.35***(0.098) |
| Below 70% | -1.834***(0.055) | - 1.823***(0.063) | - 1.826***(0.12) |
| Senior_Sec_Sch_Type | 0.313***(0.043) | 0.29***(0.047) | 0.355***(0.102) |
| Senior_Sec_Med. | 0.66***(0.062) | 0.67***(0.069) | 0.57***(0.144) |
| Constant | 6.611***(0.121) | 6.692***(0.136) | 6.557***(0.254) |
| Adjusted R-squared | 0.5008 | 0.4992 | 0.5146 |
| Observations | 3186 | 2537 | 649 |

Source: Data estimation based on primary survey.

Notes:(i) Statistical significance level: ***p < 0.01, **p < 0.05, * p < 0.1

(ii) 1&2 NCO$^{\#\#}$, represents occupations classified under National Classification of Occupations (NCO) codes 1 and 2, these occupations such as: Lecturers/professors, Army and Navy Officers, Professionals, Legislators, Senior managers, Ministry, Doctors, Bank managers, Income-tax Officers, Railway jobs, Airport authority etc.

(iii) 3 &4 NCO$^{\#}$, represents occupations classified under National Classification of Occupations (NCO) codes 3 and 4, these occupations such as: Librarians and Clerks of the University/College/School, Primary teachers, Nursing, Bank clerks, Technicians, Data entry Operators etc.

Also, the study found that there is a statistically significant difference in academic performance (CGPA) between male and female students, with 10% of male students performing better than their female counterparts at a one per cent level of significance. This finding highlights the lower academic performance of female engineering graduates compared to males. Factors contributing to this difference include social categories, economic status, previous educational background, parents' education and occupation, and institutional management etc. (Mamo *et al.*,2017; Aemiro, 2018).

Here, the above finding rejected hypothesis $H_{140}$.

Furthermore, caste and religion factors significantly affect the academic performance (CGPA) of engineering graduates. The notable finding is that graduates from Sikh and other minority groups (Jains, Buddhists and Christians) have 24.2% and 17.4% higher chances of getting good marks, respectively, while Muslims have 26% less chances of getting good marks. Subsequently, the findings show that parental education has a positive and significant relationship with the academic performance of engineering graduates. An increase in the education level of parents is related to a higher probability of engineering graduates scoring a good percentage of marks. When comparing on the basis of gender, the impact of father's

education on obtaining good grades/marks is greater among females than among males. Similarly, it also found that the effect of parent's occupation gives positive results with statistically significant. Here, the academic performance of male and female graduates is inversely related to their family's annual income.

The results reveal that achieving a higher percentage of marks in the senior secondary level is associated with better performance in graduation compared to those who score comparatively lower in the senior secondary level. This supports the finding of the study by Mersha *et al.,* (2013), which revealed that previous educational attainment is also an important factor contributing to student's poor educational outcomes at the institutional level. Additionally, students who passed out from government schools had 31.3% more chance of achieving good marks in graduation level compare to those who passed out from private schools, possibly due to the higher quality of education provided by government institutions. Finally, students who choose English as the medium of instruction at the senior secondary level have a 66 percent higher chance of obtaining good scores at the graduate level compared to students who opt for other mediums like Hindi.

### 5.4.2. Placement Outcome of Female Engineering Students

$H_{151}$ = Management of the institution, Gender, Religion, Caste, Senior_Sec_Per, Senior_Sec_Med, CGPA_ of _Grad., independent variables taken in the analysis of placement of male and female students are significantly affecting the dependent variable "placement" of engineering students, $\beta i \neq 0$[ where $\beta i$= 1,2,3,4,5,6,7].

$H_{161}$ = There is a significant difference in the placement between male and female engineering students.

The section aims to analyse the determinants of placement among engineering students and examine the disparities between males and females in placement outcomes. The placement decision of students (i.e. they get placement or not) serves as the dependent variable in the selection equation (stage-1) of the Heckman selection model, estimated using the probit model. The independent variables considered for the analysis include Management, Gender, Caste, Religion, Senior Secondary Percentage, Senior Secondary Medium and CGPA of graduates, which are hypothesized to affect the placement decision. The selection model for gender-based

placement outcomes and detailed descriptions of these variables are discussed in Chapter 3 (Ref- Equation-11, and Table-3.2).

The estimation as shown in Table-5.6, the overall marginal effect reveals that graduates of government institutions had 8.3 percentage point lower possibility of getting placement than graduates of private institutions at one percent level of statistically significant. Here, female (male) graduates from the government institutions are 8.9 (4.4) percent less likely to receive placement offers than the graduates from private institutions. It contradicts the general assumption and the finding by Choudhury (2013) that graduates from government engineering colleges/universities in India have a greater possibility of getting job than graduates from private engineering colleges. Similarly, all other variables taken in the analysis significantly influence the placement of engineering students, except Muslim religion and OBC caste.

Thus, hypothesis $H_{150}$ is rejected

**TABLE -5.6: Placement and earnings of engineering graduates: Heckman selection model**

| | Stage 1: Factors affecting Placement | | | Stage 2: Factors affecting Earnings | | |
|---|---|---|---|---|---|---|
| Explanatory Variable | Overall | Male | Female | Overall | Male | Female |
| | AME | AME | AME | Coeffi. | Coeffi | Coeffi. |
| Management | - 0.083***(0.019) | - 0.089***(0.021) | - 0.044(0.048) | 0.296***(0.022) | 0.316***(0.026) | 0.202***(0.035) |
| Gender | - 0.032**(0.017) | ……. | …… | 0.071***(0.019) | …… | ……. |
| Religion | | | | | | |
| Muslim | 0.02(0.034) | -0.034(0.04) | 0.22***(0.067) | -0.112***(0.038) | -0.123***(0.049) | - 0.066(0.058) |
| Sikh | - 0.07**(0.037) | -0.101***(0.043) | 0.023(0.077) | 0.10***(0.041) | 0.102**(0.054) | 0.05(0.052) |
| Others | - 0.05(0.047) | - 0.06(0.056) | -0.031(0.091) | 0.21***(0.047) | 0.21***(0.061) | 0.195***(0.059) |
| Caste | | | | | | |
| OBC | - 0.04(0.032) | - 0.067*(0.038) | 0.031(0.062) | - 0.02(0.035) | - 0.013(0.046) | - 0.04(0.042) |
| SC | - 0.056*(0.034) | - 0.07*(0.039) | - 0.043(0.069) | - 0.07**(0.037) | - 0.081*(0.048) | - 0.041(0.048) |
| ST | - 0.063*(0.04) | - 0.08*(0.046) | - 0.047(0.079) | - 0.06*(0.044) | - 0.06(0.056) | - 0.072*(0.057) |
| Senior_Sec._Per. | | | | | | |
| 80-90% | - 0.053***(0.023) | -0.061***(0.025) | - 0.03(0.052) | ……..... | …… | …….. |
| 70-80% | - 0.16***(0.027) | - 0.16***(0.03) | - 0.145**(0.66) | ……. | …… | …….. |
| Less than 70% | -0.19***(0.037) | - 0.19***(0.042) | - 0.17**(0.84) | ……. | …… | …….. |
| Senior_Sec._Med. | 0.051**(0.028) | 0.05*(0.032) | 0.06(0.063) | …….. | …… | …… |

| | | | | | | |
|---|---|---|---|---|---|---|
| CGPA_of_Grad. | 0.206***(0.007) | 0.21***(0.008) | 0.194***(0.017) | 0.22***(0.025) | 0.22***(0.031) | 0.254***(0.036) |
| Lambda | -0.322***(0.056) | -0.342***(0.066) | -0.20**(0.094) | …… | …… | …….. |
| Constant | -4.246***(0.296) | -4.329***(0.335) | -4.34***(0.640) | 11.668***(0.207) | 11.744***(0.249) | 11.40***(0.307) |
| Prob.>$Chi^2$ | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Observations | 3186 | 2537 | 649 | 3186 | 2537 | 649 |

Source: Data estimation based on the primary Survey
Notes: (i) Statistical significance levels: ***p < 0.01, **p < 0.05, * p < 0.1 (ii) AME: Average marginal effect.

Surprisingly, the results also reveal that around 3% of female engineering graduates are more likely to get placement offers than males. As well, in our whole sample, 54% of males (1369 from the total students 2537) and 58% of females (374 from the total students 649) have received placement offers in 2018-19. This finding is in contrast to several studies done in the context of engineering labour market in India and elsewhere (Taylor,2007; Livanos *et al.*, 2009; Choudhury,2015). This could be due to the changing labour market and education policies in the country. For instance, the NEP (2020) suggests to remove gender inequality in the labour market, where employers strive to maintain a fair ratio between female and male employees. Thereby, females are given more priority in the engineering labour market as their participation in this field is very less as compared to males, where enrolment of women in engineering at all India level is 29.9%, and it is only 21% in Delhi. This suggests that some employers are recognizing the value and potential of female engineers and are actively seeking to hire them.

Furthermore, other social factors such as religion and caste of the students are two significant factors that affect the placement of engineering students. When the study compared male and female engineering graduates across religious groups, astonishingly Muslim and Sikh females were 22% and 2.3% more likely to get job, respectively, compared to others. The disparity in placement rates between males and females is most pronounced among Muslims, with a difference of 19%. Conversely, for Sikhs and other minority groups (Jain, Buddhist, and Christian), the difference is negative. These findings highlight the higher chance of placement for Muslim females with statistical significance at the one percent level. Here, the better placement rate of Muslim and Sikh females may be attributed to the 70% reservation in enrolment for Muslim students in two engineering colleges, Jamia Millia Islamia and Jamia Hamdard, and the 75% reservation for Sikh students in a private college, GTBIT (Guru Tegh Bahadur Institute of Technology), where the number of female students from these religions is higher. Therefore, including the participation ratio of Muslim and Sikh female engineering

graduates from these three colleges provides a more comprehensive understanding of their placement prospects. Similarly, the study indicates that OBC females exhibit the highest likelihood of employment within the caste groups. Thus, the above findings indicate the differences in placement between male and female students.

So, hypothesis $H_{160}$ is rejected.

Next, the two independent variables related to previous educational information are the overall percentage of marks obtained by students at senior secondary level and the medium of study, both are statistically significant factors in determining the chance of getting placement. When male and female graduates were analysed separately, in both those who achieved higher percentage at senior secondary level and chose English as the medium of study were more likely to get placements. However, the effect of having English as the medium of study is marginally greater for females than for males. The finding agrees with previous research, which believes that human capital factors are likely to capture a significant percentage of the gender gap in employment prospects (Stephan, 1996). In addition, increase in cumulative grade-point average (CGPA) at graduation level is estimated to increase employment in case of both male and female which is statistically significant at one percent level.

### 5.4.3. Earnings Status of Female Engineering Students

$H_{171}$ = Management of the institution, Gender, Religion, Caste, CGPA_ of _Grad., independent variables taken in the analysis of earnings of male and female students are significantly affecting the dependent variable "annual earnings" of students $\beta i \neq 0$ [ where $\beta i = 1,2,3,4,5$].

$H_{181}$ = There is a significant difference in the earnings between male and female engineering students.

In this section, the study tries to analyse the factors determining the earnings of engineering students, and find out the gender gaps in earnings in the engineering labour market. The OLS technique as the second stage of Heckman selection model has been chosen to analyse this, where the dependent variable is the annual earnings of graduates (In logarithm form). The independent variables involved in determining the earnings of graduates are management,

gender, caste, religion and CGPA of the graduates. The regression model for gender-based earnings and detailed description of these variables are discussed in Chapter 3 (Ref- Equation-12, and Table-3.2). Here, OLS estimations revealed that all independent variables have a statistically significant impact on the earnings of engineering graduates (Table5.6), as detailed below.

Therefore, hypothesis $H_{170}$ is rejected.

An important institutional factor is management of the institution, significantly influencing the annual earnings of engineering graduates at the one percent level of statistical significance. The results reveal that government engineering students' annual earnings are approximately 29.6 per cent higher than those of private engineering students. This disparity may be attributed to the perceived higher talent and knowledge levels of graduates from government institutions (Choudhury, 2015). Moreover, if calculated gender-wise, male and female government engineering graduates earn 31.6 per cent and 20.2 per cent more in salaries, respectively, than their counterparts from private engineering institutes. These findings underscore the significance of institution choice in determining students' earnings and placement outcomes. As discussed earlier, private engineering graduates may have a higher placement rate, while their earnings here appear to be lower. Possible reasons for this discrepancy in earnings at private institutions may include low student productivity, inadequate networking opportunities with prominent companies, and low bargaining power.

Similarly, the estimates also found a significant gender gap in earning of engineering graduates, as expected, male engineers earn about 7 percentage more than female engineers. This finding is consistent with some previous research in India and elsewhere (Lang and Manove, 2011; Li and Miller, 2012; Choudhury, 2015; Zhang *et al.*, 2021). This could be due to employers perceiving males as more productive than females, actually employers believe that females have a dual burden (both job and domestic duties), which makes them less productive than males. Moreover, female graduates themselves tend to settle for lower wages than males and give more preference to the hiring firm's policies, such as working conditions, workplace flexibility, place of posting, transfer policies, prenatal care policies, parental leave, and childcare services, before deciding to join a job, rather than prioritizing higher wages. In contrast, males tend to focus mainly on earnings and ignore other factors. Other possible reasons for the gender differences in earnings could include gender bias, differences in

negotiation skills, variations in work experience, and differences in job responsibilities or roles etc. (Graham and Smith,2005; Moinifar, 2012). Thus, male graduates are often considered as more productive than their female counterparts, which leads to higher salaries being offered to males. Based on the above discussions, it is clear that there is a significant gender gap in earnings.

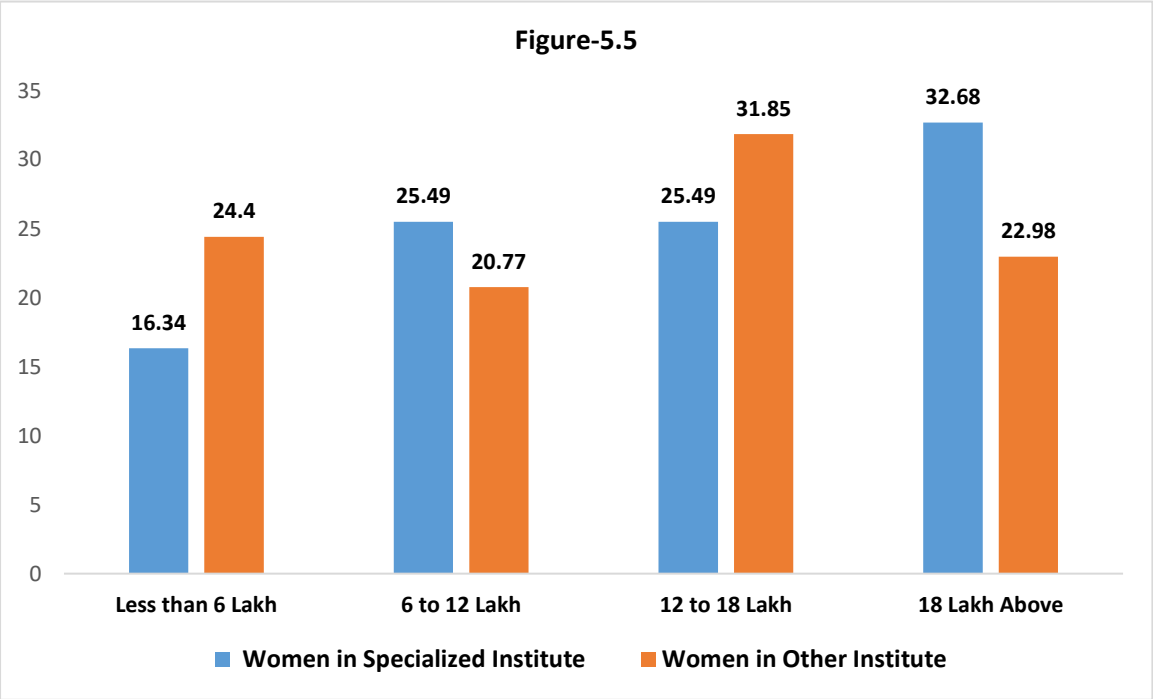
Hence, hypothesis $H_{180}$ is rejected.

Additionally, religion and caste emerge as prominent determinants of earnings, indicating clear disparities even within social caste and religious groups. Previous research corroborates these findings, revealing that SC/ST individuals often experience lower earnings compared to other groups, with discrimination prevalent across both government and private sectors. Notably, socio-religious earnings gaps are apparent, particularly among Scheduled Castes, Scheduled Tribes, and Muslims employees, underscoring the persistence of discrimination in the Indian labour market (Madheswaran and Attewell, 2007; Chakraborty and Bohara, 2021). Then, the variable cumulative Grade Point Average (CGPA) of graduate is strongly related to getting higher salaries. Individual outcomes of both male and female engineering graduates are also significantly associated with earnings. It means the students performing good in graduation level are being paid higher salaries, while those who perform poorly are being paid less.

### 5.4.4 Women in Specialized Institution and Other Institutions

As discussed earlier, IGDTUW stands as the only institution in Delhi, exclusively for female candidates (Chapter-4, Page No.88). The study tries to examine the disparity in academic performance and labour market outcomes among women at this particular institution compared to others. However, due to limited sample sizes, especially in the specialized institution, inferential statistical analysis couldn't yield significant results, particularly concerning labour market status. Moreover, the analysis of earnings faced challenges due to a smaller sample size, as it only considered students with placement offers. Consequently, the study turned to descriptive statistics, focusing on exploring the economic backgrounds of students across specialized and other institutions. Its purpose is to determine whether students from lower economic backgrounds select their specific institution or not.

**Figure – 5.5: Economic backgrounds of Women in Specialized and Other Institutions**




Source: students' questionnaire

Note: (i) Muslim specified Institutions: Jamia Millia Islamia and Jamia Hamdard (Government Category)
(ii) Sikh specified Institution: Guru Tegh Bahadur Institute of Technology (Private Category)

Among total female 649, 153(23.57%) percent were from specified colleges, and 496(76.43%) percent were from other colleges. Here, family income is considered, around 45% of the students from families earning up to one lakh/month attending general colleges. The proportion of female students from the same income group in colleges specified for women is around 42%, slightly lower than general colleges. This suggests a similar trend, or effect to a lesser degree, between specified colleges and general colleges, indicating that students from lower economic backgrounds may choose their specific institution.

## 5.5. To Sum up the Chapter

This chapter provides a comprehensive analysis of the statistically significant factors affecting the academic performance, placement and earnings of engineering students belonging to socially backward castes (SC, ST and OBC) and religious minority groups. Additionally, gender-based analyses were done considering the entire respondents. The analysis also explores

differences in academic performance, placement, and earnings across these student groups. Accordingly, the analysis was presented in three groups: among socially backward caste students, among religious minority students, and among male versus female students. The analysis included 2288 respondents from socially backward castes, and 898 respondents from religious minority groups. These respondents were B-Tech fourth year engineering graduates of engineering institutes in Delhi, who were surveyed during the academic year 2018-19. Total respondents were 3186, which were used for gender-wise analysis. Each group was examined separately.

The overall findings show that institutional factors, social categories, parents' education and occupation, family income status, and previous educational background significantly influence the academic performance (CGPA) of engineering students across different demographic groups. Similarly, institutional management, social factors and academic achievements affect their labour market outcomes (placement and earnings). Nonetheless, the effects of these factors vary among different student groups.

Also, the chapter highlighted the disparities between different student groups in academic performance, placement, and earnings in the engineering education. Within the caste groups, OBC students perform better than SC and ST students in terms of educational achievements, employment prospects and earnings. This highlights the existing inequalities among socially backward castes. Similarly, among religious minorities, Muslim students face significant academic performance disparities and lower earnings, although their chances of getting placement offers are marginally higher than that of other minority groups. This points to disparities among minorities in educational performance and the job market. Gender differences show that male engineering graduates outperform females academically, while females have slightly more employment opportunities. This employment phenomenon may result from efforts to balance the gender ratio in the workforce. However, male engineers earn higher salaries, indicating gender-based wage disparity. Overall, this chapter highlights persistent discrimination in both education and the labour market, drawing conclusions from these findings for the broader populations.

# CHAPTER-6
# CONCLUSIONS, SUGGESTIONS, AND LIMITATIONS OF THE STUDY

## 6.1. Background

While we find a significant expansion of engineering education in India, equity in access remains a major concern. And this is the case even when higher education institutions (HEIs) in India provide reservations to socially backward caste groups (SC, ST and OBC), and some specialised HEIs establishes to religious minorities and women. The most recent data shows that the share of women in engineering education is only about 30 per cent. Several studies show the low enrolment of SC and ST students in quality engineering institutions such as IITs, NITs and established government colleges (Amirtham & Kumar, 2023; Subheesh, N. P., *et al.,* 2023; Chaudhuri, B., *et al.,* 2022). Interestingly enough, aspiring youth in India are doubly disadvantaged in accessing engineering and technical education, being women and socially backward, and this put them in considerably backward positions. Why is it so important for women, socially backward groups and Muslim minorities to access to engineering and technical education? Undoubtedly, access to good quality engineering education plays a critical role in the life of socially and economically marginalised sections of Indian society. It helps them get jobs in the labour market and, more importantly, form dynamic capabilities that help them lead a quality and dignified life. For instance, positioning women and socially marginalised in leadership and entrepreneurial positions, particularly in engineering and technical fields, fosters gender and social equality, which in turn promotes overall wellbeing of human society. Therefore, looking at the support socially backward groups, religious minorities, and women get in accessing engineering education through affirmative actions and their participation in the labour market is important.

Development of all communities in the society underlines the ability to deliberately and effectively change social structure within economic contexts (Kuznets, 1971). Throughout history, specific marginalised sections of society such as Scheduled Tribes (STs), Scheduled Castes (SCs), Other Backward Classes (OBCs), religious minorities and women in India, have faced systemic exclusion from development opportunities, resulting in enduring disparities (Tilak, 1990; Azam & Blom, 2008; Singh, 2012). Recognising this, Government of India acknowledged the urgent requirement to upliftment marginalised communities including SCs,

STs, OBCs, religious minorities and women. Specifically, the government introduced reservation policies for socially backward castes (SCs, STs, and OBCs), opening educational institutions on the basis of religion and gender to uplift the marginalised communities, aiming to improve their socio-economic and educational circumstances. The implementation of such policies, especially in higher education, has given rise to extensive debate due to its growing impact on the changing socio-economic aspects of the community. Nevertheless, it provides a unique context to the impact of the affirmative actions on access, equity, and outcomes in higher education, including engineering (Chaudhary & Mishra, 2018). While several existing studies have examined the effects of reservation policies in education including higher education, across India (Jain, 2017; Choudhury & Singh, 2023), the story in engineering and technical education remains an open question. Thus, a comprehensive socio-economic analysis focused on reservations under affirmative actions in higher education, particularly in engineering, is warranted, to assess its effectiveness on marginalised or disadvantaged groups and identify areas for improvement.

It is well argued that reservations have played a significant role in increasing access to engineering education for historically marginalised communities such as Scheduled Castes, Scheduled Tribes, Other Backward Classes, religious minorities, and women (De Zwart, 2000; Hasan, 2022; Das, & Das, 2022; Chakma, & Dubey,2023; Sagarika, & Kahali, 2023). There is still a significant under-representation of these groups in engineering education (Craps, *et al.*, 2022; Neally, 2022; Riks, M., Schaefer, & Brockmann, 2022; Amirtham, & Kumar, 2023). The government and educational institutions must also focus on improving the quality of education, ensuring access to resources, and addressing discrimination and biases within the educational system. This includes providing equal opportunities to all students, regardless of their caste, religion, gender, or economic background. In this study, using a student survey data of 3186 students in Delhi, we examine the social caste, and religion groups, as well as gender inequalities in access to engineering education, academic performance and labour market outcomes. Overall, this study highlights the importance of affirmative action including reservation policies in promoting equal opportunities and addressing historical discrimination against marginalised communities. There are still some challenges that need to be addressed, particularly in terms of the underrepresentation of women, certain communities, such as Minorities, SC, ST and OBC. Though, reservations have been successful in improving access to engineering education for marginalised communities to some extent, but there is still part of building for improvement. So, it is important to continue monitoring the impact of reservations

and implementing targeted efforts to address the challenges faced by underrepresented communities in accessing engineering education.

Objectives of the study are:

(a) To discuss all affirmative programmes offered by degree level engineering institutions in Delhi.
(b) To investigate the socio-demographic and economic status of the Scheduled Caste (SC), Scheduled Tribe (ST), and Other Backward Classes (OBC), Religious Minorities and Male versus Female.
(c) To analyse and compare the academic performance, placement and earnings among SC, ST and OBC engineering students.
(d) To analyse and compare the academic performance, placement and earnings among religious minority students in engineering education.
(e) To analyse and compare the academic performance, placement and earnings of female engineering students with their male counterparts.

To analyse these objectives, institutional questionnaires and student questionnaires were used as survey instruments. Data was collected from 18 engineering institutes (13 government and 5 private) in Delhi during the academic year 2018-19. Of the 18 institutes, 3 minority institutes provide specific reservation for religious minorities and one institute is exclusively for female candidates. From the student questionnaire, the respondents collected for this study are 3186 students, divided into two groups: socially backward caste students and religious minority students. Furthermore, gender-based analysis has been conducted by combining both the groups. The analysis consists of 2288 respondents from socially backward castes (SC, ST and OBC) and 898 respondents from religious minority groups. Of the total students surveyed, the share of SC (41.22%), ST (11.67%), OBC (47.11%). The overall share of women is 20.37% (649) from the total respondents 3186. These respondents were B-Tech fourth year students of 18 engineering institutes, fourth-year students were purposively surveyed to collect information on their academic and placement experiences. Total students surveyed from government engineering institutions are 71.9% and from private institutions are 28.1%.

## 6.2 Main Findings (Objective Wise)

**Objective-1:** To discuss all affirmative programmes offered by degree level engineering institutions in Delhi.

In summary, engineering institutions in Delhi, managed by central, state, and private entities, follow central government reservation policies for SC, ST, OBC, and PWD students in enrolment. Exceptions include minority institutions like JMI, JH, and GTBIT, they do not follow central government reservation policies for SC, ST, and OBC students. JMI and JH provide 70% reservation for Muslims and GTBIT offers 75% reservation for Sikhs. Besides this, some institutions also implement additional reservation policies in enrolment, including provisions for Kashmiri migrants, children of widows of defence personnel (CWD), single girl child, management quota, residential quota, central/state board toppers, and foreign candidates. Alongside reserved seats, various affirmative programs including fee waivers, extra financial assistance, marks relaxation in admission, and various academic support, placement initiatives, specialised accommodations are offered to promote inclusivity and support marginalised groups. Overall, while significant efforts have been made to address diversity and inclusion, there remains scope for further enhancement of affirmative programs and support mechanisms. Government engineering institutes, namely IITD, NITD, DTU, NSUT, IIITD, IGDTUW, JMI, and JH offer various reservation policies in enrolment, and other affirmative programs to support marginalised groups and encourage participation in engineering education. However, expanding these initiatives could further enhance effectiveness. Other government institutions in Delhi also implement reservation policies but should also focus on providing more affirmative programs, especially for marginalised groups. Particularly, Muslim minority institutes like JMI and JH from government category, and a private institute GTBIT for Sikh minority, demonstrate higher participation rates of these minority groups, indicating the effectiveness of targeted initiatives. Interestingly, private institutions in Delhi also provide some affirmative programs including reservation policies, but they should expand their efforts further.

In the context of reservation policies in higher education including engineering, there is a notable disproportion between private and government institutions. While reserved seats in private institutions often remain unfilled, government institutions typically demonstrate better adherence to reservation norms. However, prestigious institutions like IIT Delhi often struggle

to fill their reserved seats for socially backward groups (SC, ST and OBC), reflecting a broader challenge in ensuring equitable representation through reservation policies in elite technical higher education institutions. This may reflect the entry difficulty students from socially marginalised groups face to IITs and other elite technical HEIs. For instance, a good scoring in IIT-JEE to take admission in UG engineering programme of IIT becomes difficult for socially marginalised groups and first-generation learners.

**Objective-2:** To investigate the socio-demographic and economic status of Scheduled Caste (SC), Scheduled Tribe (ST), and Other Backward Classes (OBC), Religious Minorities, and Male versus Female.

The discussion has been made for two exclusively different groups of SC, ST, OBC as well as religious minorities. The socio-demographic and economic factors are also discussed gender wise, covering both groups as a whole. Factors considered in the discussion are location of the residence, family type, parental education, occupation, and family income. This highlights the influence of family and economic factors on educational pursuits, suggesting that urban families may have better access to information and resources for engineering education. Furthermore, the association of parental education, occupation, and family's income in determining enrolment in engineering education are emphasised.

***SC, ST and OBC***

The study reveals socio-demographic and economic disparities among students belonging to the SC, ST and OBC categories. Here, students from rural areas might face different challenges and opportunities compared to those from urban settings. Similarly, variations in family size can influence students' financial stability. Moreover, parents' educational experiences can affect their preparedness for engineering.

The major findings for these groups indicate that a considerable share of students from the SC, ST and OBC categories come from lower-income family backgrounds. In each group, more than 30% of the students belong to families with an annual income of less than Rs 6 lakh. Meanwhile, SC (23.86%), ST (24.34%), and OBC (18.09%) students fall into the 6 to 12 lakhs income bracket. For families with annual income between 12 to 18 lakhs, SC (26.41%), ST (31%), and OBC (19.11%) students are present. In the highest income group, above 18 lakhs annually, consists of SC (17.07%), ST (11.24%), and OBC (33%) students. Such disparities

may put obstacles to their educational attainment and overall academic success emphasizing the need for targeted interventions and support mechanisms to ensure equitable access and opportunities in engineering education for all.

***Religious Minorities***

A higher percentage of students from urban areas are joining engineering education than students from rural areas across all minority groups. Surprisingly, there is not even a single student in Jain community who is from the rural India.

The participation of students from joint families in engineering education is considerably lower than that of nuclear families in all demographic groups. The high dependency and resource constraints may be the reasons for low participation of students from joint families to join engineering education. However, this needs further scrutiny.

The finding suggests that father's education has a positive relationship with his children's access to engineering education, as there is an increase in students' enrolment in engineering education with an increase in father's education level.

Similarly, father's occupation has a favourable effect on children's enrolment in engineering education. Specially, students whose father's occupation is 1&2 NCO category[13] and business have taken enrolment in engineering education in more numbers.

The association between mother's occupation and student's enrolment in engineering education is not very strong as most of the students' mothers are housewife. Only Christian and Jain students are more influenced by mother's 1&2 NCO category occupation to enter engineering education.

Besides this, the overall result shows that annual income of the family helps the students to enrol engineering education. However, a major share of Muslim students belongs to annual family income groups of below 6 lakhs and between 6-12 lakhs (than that of other minority groups), marking the lowest family annual income category. Therefore, there is a need to make engineering education affordable for Muslim students by formulating some favourable policies.

[13] 1&2 NCO category occupation represents occupations classified under National Classification of Occupations (NCO) codes 1 and 2, these occupations such as: Lecturers/professors, Army and Navy Officers, Professionals, Legislators, Senior managers, Ministry, Doctors, Bank managers, Income-tax Officers, Railway jobs, Airport authority etc.

***Gender***

The data suggest a significant gender disparity in engineering education, both at the national level in India and specifically in Delhi. Women's enrolment in engineering programs is considerably lower compared to male students, which poses a major issue.

In contrast to the overall women's enrolment rate of 29.9% reported by the All India Council for Technical Education (AICTE) for the academic year 2020-21, the enrolment rate for women in engineering in Delhi is only 21%. This may be due to the strong patriarchal settings of the families in northern India that keeps many women away from engineering education.

This disparity can be attributed to societal factors, specifically the influence of a patriarchal society where parents tend to invest more in the education of boys, expecting financial returns, while considering girls as assets belonging to someone else after marriage. This bias becomes more pronounced as the cost of higher education increases. Here, the overall result shows that maximum female students came from the upper middle-income group i.e. 12-18 lakhs. This suggests that the representation of women in engineering education from poor and lower-middle income families are significantly less.

**Objective-3:** To analyse and compare the academic performance, placement and earnings among SC, ST and OBC engineering students.

Among caste groups, OBC students display better academic performance, placement and earnings than SC and ST students. The academic performance of SC/ST students is about 38 per cent lower than that of OBC students, with SC/ST engineering students receiving fewer job offers and lower salaries than their OBC counterparts. This highlight existing disparities in academic and labour market outcomes among socially backward castes.

The analysis of factors determining academic performance of SC/ST and OBC students shows that institution type (government or private), caste, parents' education and occupation, annual income of the family, whether the students have received scholarship or not, past academic background of the students (medium of study and percentage of marks obtained) are statically significant. For example, the academic performance of OBC students are found to be better

than their SC/ST counterparts, students who received scholarship had better academic performance. Likewise, students whose schooling was from English medium and private schools had better academic performance.

Institution type (government or private), caste, past academic background, CGPA of engineering graduates are the major factors that determine the placement in labour market. Students studying in private engineering institutions are more likely to get placement than who are studying in government engineering institutions. This finding contradicts the study conducted by Choudhury (2015), which reported a higher employment rate among graduates from government engineering institutions compared to those from private ones. Also, OBC students have higher placement records and earnings compared to SC/ST students. This shows discrimination in the Indian labour market in engineering education within these caste groups.

**Objective-4:** To analyse and compare the academic performance, placement and earnings among religious minority students in engineering education.

A comparison is made among religious minority students on their academic preperformance and labour market outcomes i.e. the placement and earnings. Results show that Muslim students have demonstrated a substantial low academic performance, their academic performance being around 71.4% lower than that of other minority students. Even Muslim students get access to engineering education they do not well academically. The main factors that determine the low performance of Muslim engineering students are institution type (government or private), religion, parent's education and occupation, economic status of the family, past academic background. Findings show that the academic performance of Muslim students accessing private engineering institutions is less than that of students accessing government engineering institutions. This may reveal the quality differences in imparting engineering education between government and private engineering institutions. Overall the academic performance of Muslim students is relatively bad, other minority students are ahead of their Muslim counterparts.

Interestingly, Muslim students are 6% more likely to get job offers than their counterparts from other minority groups, although their earnings are almost 40% less. This reflects the tendency among Muslim students to accept jobs with lower salaries. Interestingly, the placement and earnings of Muslim students is significantly determined by their current and past academic

performance. For example, Muslim students with low CGPA ended up getting no jobs as compared students with high CGPA. Employers participating in placement exercises consider the past academic details and the CGPA obtained in engineering course as two important quality indicators to give jobs to Muslim students.

Overall, results underline the presence of discrimination among minorities in both academic performance and the job market.

**Objective-5:** To analyses and compare the academic performance, placement and earnings of female engineering students with their male counterparts.

Gender of the students plays a critical role in determining the academic performance and labour market outcomes of engineering graduates. Therefore, the analysis here looks at the role socioeconomic, and academic factors in determining the academic performance of the students and labour market outcomes by gender. Results show a considerable gender inequality in both academic performance and labour market outcomes. While the macro data shows that women's participation in the labour market is less than their male counterparts, not many studies have looked at the gender gap in academic performance and labour market outcomes. This analysis adds to the growing literature on gender and engineering education.

The analysis shows that male engineering graduates outperform females in academic performance, but females have more employment opportunities. The major factors determining the gender gap in academic performance are institution type, caste, religion, parents' education and occupation, past academic background and economic status of the family. Similarly, the most significant factors determining gender gap in labour markets are institution type, previous educational background and CGPA of current education. Better employment opportunities for females here may result from changes in the labour market and policies within the country. Companies aiming to maintain the gender ratio in the workforce, may give priority to hiring females due to their low representation in this field. However, male engineers earn about 7% more than their female counterparts, indicating gender-based wage disparity that is again in favour of males. This disparity may arise from employers perceiving males as more productive, resulting in higher salaries for male engineers. Here, female graduates face discrimination in terms of academic performance and earnings. Overall, all these findings lead to conclusions about the broader population.

These three objectives provide a comprehensive analysis of the statistically significant factors affecting the academic performance, placement and earnings of engineering students belonging to socially backward castes (SC, ST and OBC) and religious minority groups, as well as gender. The analysis also explores differences in academic performance, placement, and earnings of these student groups across different socioeconomic and demographic settings. The analysis of these groups brings out the existing disparities in academic outcomes and labour market outcomes in engineering education in India, one of the costliest disciplines in higher education.

The overall findings show that institutional factors, social categories, parents' education and occupation, family income status, and previous educational background significantly influence the academic performance (CGPA) of engineering students from different socioeconomic across demographic groups. Similarly, type of institution, social factors and academic achievements significantly affect their labour market outcomes (placement and earnings). Nonetheless, the effects of these factors vary among different student groups, based on their socioeconomic positions. Finally, it highlights wide disparities across different groups, requiring policy interventions to address academic and labour market disparities.

The findings highlighted the disparities between different student groups in academic performance, placement, and earnings in the engineering education. Within the caste groups, OBC students perform better than SC and ST students in terms of educational achievements, employment prospects and earnings. This highlights the existing inequalities among socially backward castes. Similarly, among religious minorities, Muslim students face significant academic performance disparities and lower earnings, although their chances of getting placement offers are marginally higher than that of other minority groups. This points to disparities among minorities in educational performance and the job market. Gender differences show that male engineering graduates outperform females academically, while females have slightly more employment opportunities. This employment phenomenon may result from efforts to balance the gender ratio in the workforce. However, male engineers earn higher salaries, indicating gender-based wage disparity. Overall, this analysis highlights persistent discrimination in both education and the labour market, drawing conclusions from these findings for the broader populations.

## 6.3 Suggestions and Policy Implications

Based on the findings of the study, here, we provide suggestions and policy implications for various stakeholders of the engineering education:

### 6.3.1 To the Regulatory Bodies:

1. The study clearly shows that academic performance of OBC students are better than SC and ST students. Also, the CGPA score of Muslim students is lower than that of other non-minority groups. In both caste and religious categories, male students perform better academically than their female counterparts. Therefore, regulatory bodies may take note of it and can plan for more intensive mentoring to the socially disadvantaged groups. For instance, institutions established to serve religious minority groups provide expanded opportunities for their academic pursuits. AICTE may consider granting permission for such initiatives. In addition, engineering colleges with higher enrolment of SC/ST and Muslim students should run more remedial programmes for their academic performance. It should provide more scholarships and financial aid specifically targeting SC/ST, Muslim, and female students to support their education in engineering. AICTE should fund resources to provide academic support, mentoring programs, and career guidance specifically tailored for these student groups in engineering education.
2. In areas where there is more concentration of SC/ST and Muslim students, AICTE should bring regulation of more reservations of these groups in colleges established in such areas. As the institutions established for any of the religious minorities gives them more options to pursue engineering education, hence the number of those institutions should be increased. Also, increase the number of institutions that cater specifically to women or provide a women-friendly environment in existing institutions to encourage women's participation in engineering education. The AICTE may decide to give permission for any such applications in establishing engineering institutions.
3. AICTE should make policies for quality improvements of engineering institutions, particularly for colleges where more SC/ST and Muslim students have enrolled as their employment and earnings are less than their non-SC/ST and non-Muslim

counterparts. In addition to the several efforts made at the institutional level, AICTE should also help engineering colleges to strengthen academic-industry interlinkage, which is weak in many colleges. It should allocate sufficient resources and funding to in improving infrastructure and facilities, to provide academic support, mentoring programs, and career guidance specifically tailored for women students in engineering. It is important to increase the number of qualified teaching faculty and provide sufficient academic support for socially marginalised groups and female students to improve their academic performance.

### 6.3.2 To the management of engineering institutions

1. The engineering colleges should collaborate with educational institutions, NGOs, and community organisations to create supportive environments and mentorship programs for socially marginalised and female students in engineering.
2. Provide appropriate education and training programs that equip socially disadvantaged groups and women with the necessary skills and knowledge in engineering, including attractive techniques, machines, and equipment relevant to the field. Equip engineering workshops with appropriate techniques, machines, and equipment to enhance the practical skills and confidence of backward students, including Muslims.
3. Encourage internships, apprenticeships, and industry collaborations to provide women, SC and ST engineering students with practical work experience and enhance their confidence. This would help to foster a culture of continuous learning and professional development among women engineers through workshops, seminars, and certifications.
4. It is important for the institutions to provide suitable accommodation facilities in colleges to ensure the safety and comfort of minority women students. Also, effort should be made to create library and lab facilities, internet access, classrooms, and overall campus infrastructure to meet the needs of socially backward students.
5. Encourage private institutions to improve their teaching quality, placement services, and productivity to increase the academic performance and job prospects of their graduates, particularly for minority students. Offer specific interventions and coaching facilities to improve the chances of backward students, including Muslims, achieving good academic performance.

6. Facilitate collaborations between private institutions and industries to provide practical training opportunities and exposure to real-world engineering challenges.
7. Establish mentorship and career guidance programs to assist students from socially backward caste groups in their academic and professional journey.
8. Invest in faculty development programs, modern teaching methodologies, and curriculum updates to ensure a high standard of education in private institutions.
9. Develop entrepreneurship and innovation support programs to encourage self-employment and start-ups among engineering graduates from private institutions.

### 6.3.3 To parents of engineering students and would be engineering students

1. Past academic results also matter in the performance of students during engineering education. Thus, parents should take care that their ward gives attention to provide good quality senior secondary education also while preparing for engineering entrance test.
2. Ability to communicate properly matters during the placement and also for institutional academic performance. Parents should take care that students give importance to English medium study, also beside science and mathematics.
3. Promote a shift in societal mindsets and perceptions about women's capabilities in the engineering field through awareness campaigns, media representation, and role models.
4. Educate parents and families about the importance of supporting their daughters' education and careers in engineering, challenging traditional gender roles and domestic responsibilities.

### 6.3.4 To the employers

1. Employers should value women's work and skills by ensuring equal pay for equal work and raising the wage floor to reduce the gender gap in earnings. They should provide flexible work schedules, remote working options, and support mechanisms for women engineers to balance their professional and personal responsibilities.
2. Employers should implement policies that promote women's advancement into senior and leadership roles, including mentorship programs and targeted career development initiatives. Develop specific strategies and policies to address workplace safety concerns and ensure a secure and inclusive work environment for women engineers.

3. Introduce policies and support systems that address the unique needs of young women engineers, including access to prenatal care, childcare services, and parental leave policies.
4. Encourage companies to adopt gender diversity policies and practices, ensuring equal opportunities for women in job placements and career advancement.

### 6.3.5 To the students who already joined engineering and for those who aspire to join:

1. There exists huge information asymmetry in the choice of engineering institutions and trades. Many private engineering colleges give wrong information about their placement records which attracts students to join such institutions. Therefore, it is important for students to cross verify the information provided in engineering colleges from other sources to take the right decision.
2. In addition to the academic training engineering students receive from colleges, they should attempt to sharpen their communication and technical skills through additional investment. This would help them in getting better jobs in the labour market.
3. Peer learning is an important channel for strengthening the academic performance, and thereby labour market participation, therefore, students should make attempts to strengthen this.

### 6.3.6 Overall Suggestions

1. The education and labour market policies in India should address the emerging gender inequality in engineering graduates labour market. For instance, female engineers are found to be paid less in engineering labour market than their male counterparts, and this calls for female supportive labour market policies by the employers, which will further encourage more women to the engineering discipline.

2. The academic performance of engineering students from socially marginalized groups (SC/ST, Muslims and women) has been found to be lower than that of socially better-off students. The educational policy should address this concern by providing effective remedial training program and restructured the existing program for these students. For example, initiatives should be taken to promote equity in education, particularly in STEM fields, by encouraging girls' participation and reducing sociocultural biases. It is important

to create awareness campaigns and programs to challenge gender stereotypes and promote the value of girls' education. Interestingly, this is a key recommendation of the NEP (2020).

3. Socially marginalized groups also face discrimination in the labor market after completing their engineering courses, especially as a significant proportion of engineering graduates enter the private job market. Addressing this concern should be a key policy focus. Specifically, the policy should focus on the group that are considerably discriminated (double discrimination) being women and belonging to Muslims or socially backward castes (SC/ST and OBC).
4. It is crucial for the government, employers, and society as a whole to take concerted efforts to value women's work, provide equal opportunities, and create an enabling environment for women engineers to thrive. These measures will not only benefit women individually but also contribute to a more diverse, inclusive, and productive engineering workforce.
5. By implementing these policy implications, private institutions can increase the participation of socially backward students, improve their teaching quality, enhance placement services, and create a suitable work environment. This will not only increase access to engineering education but also reduce inequalities in the engineering labour market. The private sector has a crucial role to play in ensuring equal opportunities and outcomes for all students, irrespective of their background, thereby contributing to a more inclusive and diverse engineering workforce.

## 6.4 Limitations of the Study:

Though the study has been able to clearly show the academic and labour market inequalities in engineering education for ST, SC, OBC, religious minorities, as well as gender, several questions remain to be unpacked and needs further analysis. Major limitations for the study are discussed here:

i. Performance of the Student who join engineering institutions without any reservation has not been covered. The analysis in this study has only considered SC, ST and religious minority students. A study may be conducted including general students, neglecting the perspectives and experiences of unreserved sections of society. A comprehensive analysis that includes all sections of society would provide a more holistic understanding of the issues.

ii. Qualitative variables such as quality of teaching, quality of laboratories or library, caste/ religion or gender wise behavioural discrimination has not been discussed. Quality of teaching, laboratories, equal behavioural treatment are also very important variables in the academic performance of a students but all these qualitative data have not been gathered. A separate study may be done considering all this qualitative information.

iii. The study is confined to the engineering institutions of Delhi only. Given the socioeconomic diversity in India, this study may be generalised at all-India level. This study should be replicated for other states also to get a better understanding of the issues in engineering education. As the study has focused in a metro city, more studies are needed in semi-urban and rural areas in India.

iv. The study does not include information on the assistance received by students from alumni or senior students in securing job offers. Future research may include this aspect too.

v. This study clearly limited to under graduate engineering program only. Similar study may be done for students of other discipline such as law, management, medicine etc. Likewise, studies can be done for PG and diploma courses in engineering education. Conducting similar studies in different fields would provide a more comprehensive understanding of the issues across various domains.

## 6.5 Suggestions for Future Research:

***6.5.1 Expand the Scope***: Conduct studies in other states or regions of India to capture regional variations and understand the broader dynamics of engineering education and the labour market.

**6.5.2** ***Inclusion of Unreserved Sections***: Incorporate the perspectives and experiences of unreserved sections of society to gain a comprehensive understanding of the challenges and opportunities they face in engineering education and the labour market.

***6.5.3 Include Supply-Side Variables***: Consider supply-side factors such as the quality of Teachers, physical infrastructure, number of applications, and student rankings to analyse their impact on participation in engineering education.

***6.5.4 Alumni Support Analysis***: Include data on the support received by students from alumni or senior students in securing job offers to explore its influence on students' job decisions

and outcomes.

***6.5.5 Comparative Studies***: Conduct comparative studies that analyses the applicability and generalizability of the findings across different disciplines of technical and professional education, including science, management, and law.

***6.5.6 Studying already employed engineering graduates***: For a nuance understanding of the labour market aspects of engineering education, a separate study is advocated with the graduates who have already employed in the labour market. This will give the actual labour market experiences, including the earnings.

***6.5.7 Social relevance of engineering education:*** As this study largely examines the economic and labour market relevance of engineering education, a separate study looks at the social relevance of it, particularly the marriage market and other such aspects.

## 6.6 To Sum up the Chapter

To sum up, the study discusses various affirmative programs, including reservation policies, implemented by engineering institutions in Delhi, as well as the socio-demographic and economic status of the beneficiaries of these affirmative programs. The study also provides valuable insights into the academic performance and the labour market outcome of ST, SC and OBC students, religious minorities as well as gender of engineering education at Delhi. The study uses institutional data and student survey data of engineering education with a sample size of 3186 graduates collected from 18 institutions in the academic year 2018-19. This study contributes significantly to the growing literature on engineering education and their changing relevance to labour market. The study has significant policy implications; therefore, regulatory bodies, government, and other stakeholders may refer the findings while upgrading the existing policies and interventions. This study is an initial foray in understanding the gender and socioeconomic inequalities in engineering education, and a robust research agenda lies ahead in this area as briefly out lined in section 6.5.

**References:**


Abidi, A. (2022). “Gender Disparity and Education of Muslim Girls in India: Societal and Legal Issues.”, In *Gender, Law and Social Transformation in India*, pp. 257-271. Singapore: Springer Nature Singapore.

Abidi, A., & Kazmi, R. (2019). “Muslim Girls and Higher Education: A Sociological Analysis of Patriarchy, Policy and Poverty”, Islam *and Muslim Societies: A Social Science Journal,* Vol. 12, No. 2. pp.1-15.

Abulbasal, R., Glass, C., Marquez-Velarde, G., & Martinez-Cola, M. (2023). “Exploring the Impact of Women’s Representation on the Professional Careers of Women of Color.”, *Sociological Perspectives,* Vol. 66, No. 3. pp.401-418.

Aemiro, T. (2018), "Factors affecting the academic performance of female students at higher education in Ethiopia", *Global Journal of Human-Social Science: G Linguistic & Education,* Vol. 18, No. 2, pp. 25-28.

Aftab, Ahmad, Ansari. (2022). “Study of socio-economic status and certain personal factors of B.tech. students.” Paripex Indian Journal of Research, Vol.11, No.2, pp.81-84. doi: 10.36106/paripex/3508189.

Ahmad J. (2014). “Problems in pursuing science education among Muslim girls at senior secondary level” Scholarly research journal for interdisciplinary studies (SRJIS), VOL-II, No. XIV, pp. 1949-1957.

Ahmad, M. (2022). “Effect of Reservation Policy on Employment of Scheduled Castes and Scheduled Tribes in Public Sector.”, In *Mapping Identity-Induced Marginalisation in India: Inclusion and Access in the Land of Unequal Opportunities.* pp. 155-176. Singapore: Springer Nature Singapore.

Ahmed, N., Chowdhury, A. M., Urmi, T. and Jamal, L. (2022), “Impact of Socio-Economic Factors on Female Students’ Enrolments in Science, Technology, Engineering and Mathematics and Workplace Challenges in Bangladesh”, *American Behavioural Scientist*.

Ahmed, S. (2015). “Dynamics and diversity: How are religious minorities faring in the labour Market in Bangladesh?”, *Research Papers in Economics, Munich Personal RePEc Archive (MPRA),* No. 75153, pp. 1-47

AICTE. (2012). Annual Report, “All India Council for Technical Education”, New Delhi.

AICTE. (2020). Annual Report, “All India Council for Technical Education”, New Delhi.

AICTE. (2022). Annual Report, “All India Council for Technical Education”, New Delhi.

Alabdulkarem, A., Alhojailan, M. and Alabdulkarim, S. (2021). “Comprehensive investigation of factors influencing university students’ academic performance in Saudi Arabia”. *Education Sciences,* Vol. 11, No. 8, pp.375.

Alam, M.M., Billah, M.A. and Alam, M.S. (2014). "Factors affecting academic performance of undergraduate students at International Islamic University Chittagong (IIUC), Bangladesh". *Journal of Education and Practice*, Vol. 5, No. 39, pp.143-154.

Alesina, A., Hohmann, S., Michalopoulos, S., & Papaioannou, E. (2023). "Religion and educational mobility in Africa.", *Nature*, Vol.*618,* No.7963, pp. 134-143.

Ali, M.S. and Jalal, H., 2018. "Higher Education as a Predictor of Employment: The World of Work Perspective." *Bulletin of Education and Research*, Vol. 40, No. 2, pp.79-90.

Ali, S. R. and Bagheri, E. (2009). "Practical suggestions to accommodate the needs of Muslim students on campus", *New Directions for Student Services*, No. 125, pp.47-54.

Ali, S., Haider, Z., Munir, F., Khan, H. and Ahmed, A. (2013). "Factors contributing to the students' academic performance: A case study of Islamia University Sub-Campus". *American journal of educational research*, Vol. 1, No. 8, pp.283-289.

Ali, S., Khan, N., & Majeed, S. (2020). "Academic distress, perceived parental support, self-determination, and academic success among government and private university students." *Pakistan Journal of Physiology*, Vol. 16, No. 1, 44-47.

Ali., I. (2021). "Social Inequalities among Muslims in India: A Sociological Study on Inter-Religious Perspective.", Journal of Political Sciences & Public Affairs, Vol. 9, No. 9. pp. 1-5.

Ali., S., Kanwal., Z., Muhammad, M. (2022). "Perceptions of Minority Students Regarding Job Opportunities." *Global regional review*, Vol. VII, No. II. pp.295-302. doi: 10.31703/grr.2022(vii-ii).28

Allarahamali, kumar, R. & Maurya, P.K. (2022). **"**Indian Muslim Women and Education-Status, Issues and Remedies." *Journal of Positive School Psychology*, Vol. 6, No. 3, pp. 10038-10044.

Alpay, E. (2013). "Student attraction to engineering through flexibility and breadth in the curriculum", European *Journal of Engineering Education*, Vol.*38, No.*1, pp.58-69.

Amirtham S, N., & Kumar, A. (2023). "The underrepresentation of women in STEM disciplines in India: a secondary analysis.", *International Journal of Science Education*, Vol. 45, No. 12. pp.1008-1031.

Anderson, D. M., Broton, K. M., & Monaghan, D. B. (2023). "Seeking STEM: The Causal Impact of Need-Based Grant Aid on Undergraduates' Field of Study.", *The Journal of Higher Education*, Vol. *94, No.*7, pp. 921-944.

Angwaomaodoko, E. (2023). "Influence of Gender on Career Choice and Academic Performance.", *International Journal of Education, Learning and Development*, Vol.11, No. 5. pp.1-14.

Arora, N. and Singh, N. (2017). "Factors Affecting the Academic Performance of College Students". *Journal of Educational Technology*, Vol.14, No. 1, pp. 47-53.

Arora, R. (2023). "Access of Students with Disabilities (SWDs) to Higher Education in India with Special Reference to Panjab University, Chandigarh, India." *Indian Journal of Public Administration*, Vol. 69, No. 2, 360-371.

Arun-Kumar, D. (2008). "Impact of globalization on core engineering education in India", *Perspectives on Global Development and Technology*, Vol.*7*, No.1, pp.55-68.

Asadullah, M.N., & Yeasmin, D.M., (2022). "Socio-Economic Impact of Women Education in India.", International Journal of Research Publication and Reviews, pp:785-788. doi: 10.55248/gengpi.2022.3.2.9

Ashraf, Y. and Kumar, S.S. (2019). "Personal Problems Faced by Muslim Girls in Higher Education". *Think India Journal*, Vol. 22, No. 14, pp. 846-852.

Ata-Aktürk, A., & Demircan, H. Ö. (2021). "Supporting preschool children's STEM learning with parent-involved early engineering education." *Early Childhood Education Journal*, Vol. 49, No. 4, 607-621.

Ayisha, E. A., Vijay, A., Parvathy, I., Sarath, S., & Subheesh, N. P. (2022, October). "Rural School Students' Attitudes and Perceptions toward the Engineering Education and the Engineering Profession." In *2022 IEEE Frontiers in Education Conference (FIE)* pp. 1-7. IEEE.

Azam, M., & Blom, A. (2008). "Progress in Participation in Tertiary Education in India from 1983 to 2004", World Bank Policy Research Working Paper, (4793).

Babu, D. S., Prasad, C. B., & Kapur, D. (2022). "Reimagining Merit in India.", *Making Meritocracy: Lessons from China and India, from Antiquity to the Present*, *284*.

Bahl, S., & Sharma, A. (2021). "Education–occupation mismatch and dispersion in returns to education: evidence from India.", *Social Indicators Research*, Vol. 153, No. 1, 251-298.

Bahri, C. (2016, Jul-23). "Muslims have the lowest rate of enrolment in higher education in India.", IndiaSpend.com.

Baiju, K. C. (2023). "Nexus of multidimensional poverty and educational deprivation among the social groups: Evidence from a developing country.", Journal of Governance and Regulation, Vol. 12, No. 1. pp:147-158. doi: 10.22495/jgrv12i1art14.

BalaKoteswari, M. (2022). "Issues and challenges of women in career advancement in higher education", *Journal of Management and Science*, Vol. 12, No. 2. pp.44-48.

Balakrishnan, B. and Low, F. S. (2016), "Learning Experience and Socio-Cultural Influences on Female Engineering Students' Perspectives on *Engineering Courses and Careers", Minerva*, Vol. 54, No. 2, pp. 219-239.

Balasubramanian, P. (2020). "Subjective returns to education: Rational expectations of disadvantaged groups in India.", No. 2020/107. WIDER Working Paper.

Banerjee, R., & Muley, V. P. (2007). "Engineering education in India", *Report to Energy Systems Engineering, IIT Bombay, sponsored by Observer Research Foundation, September*, 14.

Banker, D. V. and Banker, K. (2017), "Women in Leadership: A Scenario in Indian Higher Education Sector", Riding the New Tides: Navigating the Future through Effective People Management, pp. 239-251.

Barbhuyan, M. N., & Goswami, G. (2015). "An Analytical Study of the Problems of Muslim Women in Higher Education." *Cross-Currents: An International Peer-Reviewed Journal of Humanities & Social Sciences*, Vol. *1*, No. 2, pp.59-62.

Barkhuizen, E. N., Masakane, G., & van der Sluis, L. (2022). "In search of factors that hinder the career advancement of women to senior leadership positions." *SA Journal of Industrial Psychology*, Vol. 48, No. 1, pp.1-15.

Bartolj, T., & Polanec, S. (2021). "An empirical analysis of the effects of student work and academic performance on the probability of employment." *Economic and Business Review*, Vol. 23, No. 1. pp. 26-39.

Basant, R. (2012). "Education and employment among Muslims in India: An analysis of patterns and trends", Series/Report no.: W.P, pp.2012-09-03.

Basu, S. (2021). "An Economic Analysis of the Reservation Policy in India", *Policy Perspectives*, Vol. *28*, No. 1, pp.1-14, doi: 10.4079/PP. V28I0.2

Baum, S. and Payea, K., 2005. "The benefits of higher education for individuals and society.", *Education Pays 2004: Trends in Higher Education Series*.

Becerra, M. B., Gumasana, R. J., Mitchell, J. A., Sami, S., Truong, J. B., & Becerra, B. J. (2023). "Triple Jeopardy of Minority Status, Social Stressors, and Health Disparities on Academic Performance of College Students.", *International Journal of Environmental Research and Public Health*, Vol. 20, No. 13. pp. 6243, doi: 10.3390/ijerph20136243

Behera, M., & Mathew, N. V. (2022). "Underrepresentation of Marginalised Groups in India's Higher Education Institutions: A Critical Analysis." *Indian Journal of Human Development*, Vol. 16, No. 3, pp: 618-626.

Berlanga, V., Corti, F., & Perea Muñoz, E. (2022). "The Effect of Scholarships on University Persistence: A Case Study." *Review of Research and Social Intervention*.

Bertrand, M., Hanna, R., & Mullainathan, S. (2010). "Affirmative action in education: Evidence from engineering college admissions in India." *Journal of Public Economics*, Vol. 94, No. 12, pp. 16-29.

Bevelander, P. and Otterbeck, J. (2010). "Young people's attitudes towards Muslims in Sweden." *Ethnic and Racial Studies*, Vol. 33, No. 3, pp. 404-425.

Bhagat, R. B., Singh, A., & Kumar, S. (2020). "Reservation Policy in Higher Education in India: A Critical Review." Contemporary *Education Dialogue*, Vol. 17, No. 1, pp. 9-28.

Bhardwaj, A. and Kumar, V., (2022), "Web and social media approach to marketing of engineering courses in India", International *Journal of Business Innovation and Research*, Vol. *27, No.* 4, pp.541-555.

Bhargava, R.N. (2001), "Present Engineering Education in India-An Emerging Economy – And a Glimpse of the Scenario in the 21st Century", *Educating the Engineer for the 21st Century, Springer,* pp. 77-80.

Bhattacharjee, S., & Roy Chaudhuri, A. (2023). "Religion in the labor market: evidence from India.", *Applied Economics,* Vol. 55, No. 41. pp. 4781-4816.

Bhattacharya, B., (2008), "Engineering education in India–the role of ICT", *Innovations in education and teaching International,* Vol. *45, No.*2, pp.93-101.

Bhaumik, S.K. and Chakrabarty, M. (2009). "Is education the panacea for economic deprivation of Muslims? Evidence from wage earners in India, 1987–2005.", *Journal of Asian Economics,* Vol. 20, No. 2, pp. 137-149.

Bing, B., (2023), "The impact of higher education on high quality economic development in China: A digital perspective.", *Plos one,* Vol. *18,* No.8, p. e0289817.

Biswas, M. (2018). "Reservation Policy in India: Urge for Social Justice and Equality in Education and Government Services", *International Journal of Research and Analytical Reviews,* Vol. 5, No. 3, pp. 80-85.

Blosser, E. (2024). "Undoing Gender: How Young Women Decide to Become Engineers." *Journal of Women and Minorities in Science and Engineering,* Vol. 30, No. 4.

Bock, S.J., Taylor, L.J., Phillips, Z.E. and Sn, W. (2013). "Women and minorities in computer science majors: Results on barriers from interviews and a survey.", *Issues in Information Systems,* Vol. 14, No. 1, pp.143-152.

Boni, A., & Walker, M. (2016). "Universities and Global Human Development: Theoretical and empirical insights for social change (1st ed.).", Routledge. https://doi.org/10.4324/9781315742793.

Bordoloi, R. (2012). "Accessibility and equity: A challenge for higher education in India". *Journal of Economics and Sustainable Development,* Vol. *3, No.* 4, pp.67-78.

Borooah, V. K., & Iyer, S. (2005). "Vidya, Veda, and Varna: The influence of religion and caste on education in rural India.", *The Journal of Development Studies,* Vol. *41, No.* 8, pp. 1369-1404.

Boyadjieva, P., & Ilieva-Trichkova, P. (2023). "Adult education as a pathway to empowerment: Challenges and possibilities", *Lifelong Learning, Young Adults and the Challenges of Disadvantage in Europe,* pp.169-191.

Brahmanandam, T. (2023). "Dalit Discrimination in Higher Education: A Malady Without Remedies", *Contemporary Voice of Dalit,* 2455328X221144350.

Brisbane, J., Gallagher, E., Dunwoody, L. A., Hines, A., Murphy, J. C., Patel, K., ... & Gramopadhye, A. (2019). "Familial influences affecting student pathways to engineering at two-year and four-year institutions.", *2019 CoNECD-The Collaborative Network for Engineering and Computing Diversity*.

Bueno, E. H., Velasquez, S. M., Deil-Amen, R., & Jones, C. (2022, April). "That Was the Biggest Help": The importance of familial support for science, technology, engineering, and math community college students. In *Frontiers in Education*, Vol. 7, p. 768547. Frontiers.

Carreira, P., & Lopes, A. S. (2017). "The academic performance of student-workers in higher education–increasing rapidly regions' intellectual capital.", In 24th APDR Congress.

Census Report. (2011). Government of India, Ministry of Minority Affairs.

Chakma, P., & Dubey, R. (2023). "Marginalisation of Scheduled Tribes in Educational Institutions: A Case of Shrinking Public Sphere." In *Marginality in India*, pp. 82-94. Routledge India.

Chakrabarty, T. (2022). "Merit, Capital and Middle Class: Exploring the Linkages.", *Indian Journal of Human Development*, Vol. *16, No.* 1, pp.158-168.

Chakraborty, S. and Bohara, A.K. (2021), "The Cost of Being 'Backward' in India: Socio-religious Discrimination in the Labour Market", *Indian Journal of Human Development*, Vol. 15, No. 2, pp. 252-274.

Chalam, K. S. (1990). "Caste reservations and equality of opportunity in education", Economic and Political Weekly, pp. 2333-2339.

Chan, R. C. (2022). "A social cognitive perspective on gender disparities in self-efficacy, interest, and aspirations in science, technology, engineering, and mathematics (STEM): The influence of cultural and gender norms.", *International Journal of STEM Education*, Vol. 9, No. 1. pp.1-13.

Chankseliani, M., & McCowan, T. (2021). "Higher education and the sustainable development goals", *Higher Education*, Vol. *81*, No. 1, pp.1-8.

Chankseliani, M., Qoraboyev, I., & Gimranova, D. (2021). "Higher education contributing to local, national, and global development: new empirical and conceptual insights.", *Higher Education*, Vol. 81, No.1, pp. 109-127.

Chatterjee, A., & Burns, S. (2021). "Links between disadvantage and educational achievement in a low-income urban setting in Bangalore, India.", *International Journal of Psychology and Educational Studies*, Vol. 8, No. 4, pp. 223-236.

Chatterjee, P. (2016), "Women empowerment through Engineering Education: Opportunities and challenges", IOSR *Journal of Humanities and Social Science* (IOSR-JHSS), Vol. 21, No. 2, pp. 98-102.

Chaudhuri, B., D'Souza, M., & Srinivasan, J. (2022). "Bringing the missing women back: CS education for women in India's engineering institutions.", *Communications of the ACM*, Vol. *65, No.* 11, 65-67.

Cho, E. E. (2014). "The Impact of Reservation Policy on Education in India: An Evaluation of Karnataka's Gram Panchayat Presidency Reservation and Children's Education Attainment for Scheduled Caste and Scheduled Tribe Households."

Choirudin, C., Degeng, I. N. S., Kuswandi, D., Purnomo, P., & Maba, A. P. (2022). "Career readiness among low-income Muslim students", International Journal of Evaluation and Research in Education, Vol. 11, No. 3. pp. 1400-1400. doi: 10.11591/ijere. v11i3.22727

Chopra, S., Khan, A., Mirsafian, M. and Golab, L. (2019), "Gender Differences in Science and Engineering: A data mining approach", In EDBT/ICDT Workshops.

Choudhury, P. K. (2013), "Determinants of Employment Probabilities and Expected Earnings of Engineering Graduates: An Empirical Study in Delhi, India", *Journal of Income and Wealth*, Vol. 35, No. 2, pp.131-146.

Choudhury, P.K. (2015), "Explaining Gender Discrimination in the Employment and Earnings of Engineering Graduates in India", *Journal of Educational Planning and Administration*, Vol. 29, No. 3, pp. 225-246.

Choudhury, P.K., (2016), "Growth of engineering education in India: Status, issues and challenges", *Higher Education for the future*, Vol. *3, No.*1, pp. 93-107.

Chowdhury, H. and Alam, F., (2012), "Engineering education in Bangladesh–an indicator of economic development", *European Journal of Engineering Education*, Vol. *37, No.* 2, pp. 217-228.

Cismaru, D. M., Corbu, N., Frunzaru, V., Hâj, C. M., & Ştefăniţă, O. (2022). "The Impact of Social Scholarships and of Reserved Places for Graduates from Rural High Schools in Improving Access to Higher Education and Academic Performance.", In *Higher Education in Romania: Overcoming Challenges and Embracing Opportunities* (pp. 53-70). Cham: Springer International Publishing.

Craig, C. J., Verma, R., Stokes, D. W., Evans, P. K., & Abrol, B. (2021). "Parents' Influence on Undergraduate and Graduate Students' Entering the STEM Disciplines and STEM Careers." In *Preparing Teachers to Teach the STEM Disciplines in America's Urban Schools,* Vol. 35, pp. 109-133. Emerald Publishing Limited.

Craps, S., Cannaerts, M., Veldman, J., Draulans, V., Van Laar, C., & Greet, L. (2022). "Enhancing (future) students' sense of belonging to increase diversity and inclusion in engineering.", In *Towards a new future in engineering education, new scenarios that european alliances of tech universities open up*, pp. 215-224. Universitat Politècnica de Catalunya.

Creswell, J.W. 2012. "Educational Research: Planning, Conducting and Evaluating Quantitative and Qualitative Research.", (4th ed.). Boston, MA: Pearson Education.

Dalessandro, C., & Lovell, A. (2023). "Influence and Inequality: Worker Identities and Assessments of Influence over Workplace Decisions.", *Social Sciences*, Vol. 12, No. 4. pp.205.

Dar, M. A., Aziz, S., & Mir, M. I. (2022). "In an Age of Violence, Minorities, and Their Empowerment: An Indian Perspective.", In *Fighting for Empowerment in an Age of Violence.* pp. 1-20. IGI Global.

Das, D. (2019). "Academic resilience among children from disadvantaged social groups in India.", *Social Indicators Research,* Vol. *145, No.* 2, pp. 719-739.

Das, P. (2018). “Wage gap and employment status in Indian labour market.” *World Journal of Applied Economics*, Vol. *4, No.* 2, pp. 117-134.

Das, S. K., & Das, N. K. (2022). “Reservation in India: Social Justice or Political Agenda?”, *RESEARCH REVIEW International Journal of Multidisciplinary*, Vol. 7, No. 10, pp. 167-174.

Dasgupta, N., & Stout, J. G. (2014). “Girls and women in science, technology, engineering, and mathematics: STEMing the tide and broadening participation in STEM careers.” *Policy Insights from the Behavioral and Brain Sciences,* Vol. 1, No. 1. pp. 21-29.

Dasgupta, U., Mani, S., Sharma, S., & Singhal, S. (2023). “Social Identity, Behaviour, and Personality: Evidence from India”, *The Journal of Development Studies*, Vol. 59, No. 4, pp. 472-489.

Dash, M. and Bosel, A. (2020), “A Study of Technical Employability of Engineering Graduates in India”, *Journal of Entrepreneurship and Management*, Vol. 9 No. 1, pp. 1-6.

De Freitas, C. C. S. (2018, November). “Social Empowerment through Engineering Education in Developing Countries.”, In *2018 World Engineering Education Forum-Global Engineering Deans Council (WEEF-GEDC)*, pp. 1-5. IEEE.

De Zwart, F. (2000). “The logic of affirmative action: Caste, class and quotas in India.”, *Acta Sociologica*, Vol. 4*3, No.* 3, pp. 235-249.

Deshpande, A., & Sharma, S. (2016). “Disadvantage and discrimination in self-employment: caste gaps in earnings in Indian small businesses.”, *Small Business Economics*, Vol. *46, No.* 2, pp. 325-346.

Dhaktode, N. (2021). “Higher Education in India and Austria: State Approach and Impact on Students from Marginalised Communities.” *Prabuddha:Journal of Social Equality*, Vol. *6, No.* 1, pp. 39-54.

Dhotrekar, A., 2022. “Merit, Caste, And Reservation: The Conundrum.”, *Journal of Positive School Psychology*, Vol. 6, No. 7, pp. 4719-4727.

Di Paolo, A., & Matano, A. (2022). “The impact of combining work with study on the labour market performance of graduates: the joint role of work intensity and job-field match.”, *International Journal of Manpower*, Vol. 43, No. 7. pp. 1556-1578.

Dinesha P.T. (2015). “Reservation and Higher Education in India: An Overview.”, Bulletin of *Indian Society and Culture*, Vol. 2, No. 11, pp. 28-40.

Dubey, A., Mehndiratta, A., Sagar, M. and Kashiramka, S. (2019). “Reforms in technical education sector: evidence from World Bank-assisted Technical Education Quality Improvement Programme in India”, *Higher Education*, Vol. 78, No. 2, pp.273–299.

Dunn, D. (1993). “Gender inequality in education and employment in the scheduled castes and tribes of India.”, *Population Research and Policy Review*, Vol. 12, No. 1, pp. 53-70.

Eardley, E. and Manvell, J. (2006). “Legal remedies for girls' under-representation in nontraditional career and technical education”, *International Journal of Manpower*, Vol. 27, No. 4, pp. 396-416.

Edgerton, J. D., Roberts, L. W., & von Below, S. (2011). “Education and quality of life.”, *Handbook of social indicators and quality of life research*, pp: 265-296.

Edwards, D., & Coates, H. (2011). “Monitoring the pathways and outcomes of people from disadvantaged backgrounds and graduate groups.”, *Higher Education Research & Development*, Vol. *30, No.* 2, pp.151-163.

Escoda, L., Planella, J., & Suñol, J. J. (2019). “Students support in higher education: an experience with mentors.”, In *Edulearn19 Proceedings* (pp. 5977-5982). IATED, doi: 10.21125/EDULEARN.2019.1438

Etim, A. S. (2023). “Boosting Students' Performance, Career Readiness, and Earnings: An Analysis Based on the Context of Poverty Reduction.”, In *Handbook of Research on Solutions for Equity and Social Justice in Education* pp. 78-87. IGI Global.
European Journal of Education, Vol. 52, No.4, pp.414–420.

Farca, S., & Gheorghe, O. (2023). “Difficulties in Accommodating Students with the Academic Environment.”, *Revista Romaneasca pentru Educatie Multidimensionala,* Vol. 15, No. 1. pp.551-563.

Finch, H., & Finch, M. E. H. (2022, April). “The relationship of national, school, and student socioeconomic status with academic achievement: A model for Programme for International Student Assessment Reading and Mathematics scores.”, In *Frontiers in Education* , Vol. 7, p. 857451). Frontiers Media SA.

Fortenberry, N. L. (1994). “Engineering, Education, and Minorities: Where Now*.”, Journal of Women and Minorities in Science and Engineering*, Vol.1, No. 2, pp. 89-97.

Forth, J., Theodoropoulos, N., & Bryson, A. (2023). “The role of the workplace in ethnic wage differentials.”, *British Journal of Industrial Relations,* Vol. 61, No. 2. pp.259-290.

Froy, F., Pyne, L., (2011). “Ensuring Labour Market Success for Ethnic Minority and Immigrant Youth.”, Research Papers in Economics, doi: 10.1787/5KG8G2L0547B-EN

Gaikwad, H. V., & Pandey, S. (2022). “Finding My Place in This Man’s World–Investigating the Perspectives of Equity in Engineering Education.”, Journal of Engineering Education Transformations 35(Special Issue 1), pp. 207-214. doi.10.16920/jeet/2022/v35is1/22030

García-Vita, M. D. M., Medina-García, M., Polo Amashta, G. P., & Higueras-Rodríguez, L. (2021). “Socio-educational factors to promote educational inclusion in higher education.”, *A question of student achievement. Education Sciences,* Vol. 11, No. 3. pp. 123.

Geetha Rani, P. (2014). “Disparities in earnings and education in India.” *Cogent Economics & Finance,* Vol. 2, No. 1. p. 941510.

GOI. (2011). “Census Report”, Ministry of Minority Affairs, Government of India, https://www.minorityaffairs.gov.in.

GOI. (2015). “Constitution of India”, Ministry of Law and Justice (Legislative Department), Government of India, 9th November, https://www.iitk.ac.in/wc/data/coi-4March2016.pdf

GOI. (2018). “Report of the National Commission for Backward Classes”, Government of India, http://www.ncbc.nic.in/User_Panel/UserView.aspx?TypeID=1025.

Gorman, E. H., & Kay, F. M. (2020). “Skill development practices and racial-ethnic diversity in elite professional firms.”, *In Professional work: Knowledge, power and social inequalities*, pp. 115-145. Emerald Publishing Limited.

Goswami, N. (2022). “Unequal higher educational attainment across social backgrounds in West Bengal, India: a sociological analysis.”, *Cogent Social Sciences*, Vol. *8, No.* 1, 2144135.

Govindarajoo, M. V., Selvarajoo, N. A. D., & Ali, M. S. (2022). “Factors contributing to poor academic achievement among low performing pupils: A case study.”, Asian *Journal of University Education,* Vol. 18, No. 4. pp.981-997.

Graham, J.W. and Smith, S.A. (2005), “Gender differences in employment and earnings in science and engineering in the US”, Economics of Education Review, Vol. 24 No.3, pp. 341–354.

Gupta, D. P., & Dewanga, A. (2012). “Challenges before engineering education in India.”, *Researchers World,* Vol. 3, No. 2. pp. 100.

Gupta, N. (2012), “Women Undergraduates in Engineering Education in India: A Study of Growing Participation”, Gender*, Technology and Development,* Vol. 16, No. 2, pp.153–176.

Gupta, N. (2019). “Intersectionality of gender and caste in academic performance: quantitative study of an elite Indian engineering institute.”, *Gender, Technology and Development,* Vol. 2*3, No.* 2, pp.165-186.

Gupta, P., & Kothe, S. (2022). “What explains caste-based wage inequalities and earning gaps in the Indian labour market? Theil and Oaxaca decomposition analysis.”, *The Indian Economic Journal*, Vol. *70, No.* 3, pp. 514-532.

Gutiérrez-de-Rozas, B., López-Martín, E., & Carpintero Molina, E. (2022, August). “Defining the profile of students with low academic achievement: A cross-country analysis through PISA 2018 data.”, *In Frontiers in Education*, Vol. 7, p. 910039. Frontiers.

Haflongber, D. (2022). “A study on adjustment problems of undergraduate students in relation to their socio-economic status.”, International Journal of Health Sciences (IJHS), 2746-2751. doi: 10.53730/ijhs.v6ns3.6178

Haider, S. (2021). “Issues and challenges of Muslim Women in the context of Islam: A Study of Kishanganj District.”, *International journal of economic perspectives*, Vol. 15, No. 1. pp. 406-413.

Haokip, S. (2019). “Reservation policy in India: The Practice of Reservation policy on Education in India.”, Journal of emerging technologies and innovative research, Vol. *60, No.* 5:619-633-619-633.

Haq, R., Klarsfeld, A., Kornau, A., & Ngunjiri, F. W. (2020). “Diversity in India: Addressing caste, disability and gender.”, *Equality, Diversity and Inclusion: An International Journal*, Vol. 39, No. 6, pp. 585-596.

Hardtke, M., Khanjaninejad, L., Lang, C., & Nasiri, N. (2022). “Gender complexity and experience of women undergraduate students within the engineering domain.”, *Sustainability*, Vol. *15, No.* 1, p. 467.

Hasan, Z. (2022). “*Other Backward Classes and the politics of reservations in India: Past and present”,* (No. 2022/119). WIDER Working Paper.

Heckman, J.J. (1979). “Sample Selection Bias as a Specification Error”, Econometrica*: Journal of the econometric society*, Vol. 47, No. 1, pp.153–161.

Heleta, S., and Bagus, T. (2021). “Sustainable development goals and higher education: leaving many behind”, *Higher Education*, Vol. *81*, No.1, pp.163-177.

Henriksen, E. K., Dillon, J., & Pellegrini, G. (2014). “Improving participation in science and technology higher education: Ways forward.”, *In Understanding student participation and choice in science and technology education*, pp. 367-377, Dordrecht: Springer Netherlands.

Henry, O., & Ferry, M. (2017). “When cracking the JEE is not enough; Processes of elimination and differentiation, from entry to placement, in the Indian Institutes of Technology (IITS)”, South Asia Multidisciplinary Academic Journal, No. 15.

Hill, K., Hoffman, D. and Rex, T.R., 2005. “The value of higher education: Individual and societal benefits.”, *Arizona State University, Tempe, AZ, USA*.

Holladay, C. L., Cavanaugh, K. J., Perkins, L. D., & Woods, A. L. (2023). “Inclusivity in Leader Selection: An 8-Step Process to Promote Representation of Women and Racial/Ethnic Minorities in Leadership.”, *Academic Medicine*, Vol. 98, No. 1. pp. 36-42.

Holthaus, P. (2023). “Interactive robots as inclusive tools to increase diversity in higher education.”, *arXiv preprint arXiv:2303.01316*.

Hosaka, M. (2014), “Women’s experience in the engineering laboratory in Japan”, European *Journal of engineering education*, Vol. 39, No. 4, pp. 424–431.

Huang, G. (2000). “Entry and Persistence of Women and Minorities in College Science and Engineering Education”, National Center For Education Statistics, *Research and Development Report*, pp. 2 000-601.

Hussain, M., Khan, M, & Khan, F. A. (2018). “Educational status of Muslim women in India: Issues and challenges.”, Scholars *Journal of Arts, Humanities and Social Sciences*, Vol.6, No. 3, pp. 311-316.

Imasogie, B. I., Oyatogun, G. M., & Taiwo, K. A. (2018, November). "Enhancing gender balance in engineering education and practice.", *In 2018 World Engineering Education Forum-Global Engineering Deans Council (WEEF-GEDC)*, pp. 1-8. IEEE.

Ionescu, A.M. and Cuza, A.I. (2012). "How does education affect labour market outcomes?", *Review of Applied Socio-Economic Research*, Vol. 4, No. 2, pp.130-144.

Iqbal, S. (2012). "Indian Muslims and higher education: A study of Select University in North and South India". *Jamia Millia Islamia, New Delhi*.

IRUM, S., BHATTI, D. T., & MUNSHI, D. P. (2015). "Study on problems faced by women in higher educational institutions in Sindh, Pakistan". *The Sindh University Journal of Education-SUJE*, Vol.44, No. 1, pp.173-191.

Jaina be, S. (2017). "Muslim Girl's Education: A Critical Study of Ismat Chughtai's: A Life in Words", *International Journal of Latest Technology in Engineering, Management & Applied Science* (IJLTEMAS) Volume Vol. VI, No. IV.

Jamatia, P. L. (2023). "THE IMPACT OF PARENTAL ECONOMIC CHALLENGES ON WOMEN'S EDUCATION IN INDIA.", *International Journal of Economic, Business, Accounting, Agriculture Management and Sharia Administration (IJEBAS)*, Vol. 3, No. 4, 1138-1146.

Jarvie-Eggart, M. E., Singer, A. M., & Mathews, J. (2020, June). "Parent and family influence on first-year engineering major choice.", In *2020 ASEE Virtual Annual Conference Content Access*.

Jasubhai, S., (2023). "Unveiling the Unseen: Exploring the Hidden Struggles Faced by College Students", Vol.2, No.1, pp. 09-012, doi: 10.33597/2692-7934-v2-id1013.

Jha, P. and Nagar, N. (2015). "A Study of Gender Inequality in India", *The International Journal of Indian Psychology*, Vol .2, No. 3, pp. 46-53.

Jongbloed, B., Enders, J. and Salerno, C., 2008. "Higher education and its communities: Interconnections, interdependencies and a research agenda.", *Higher education*, Vol. *56*, pp. 303-324, https://doi.org/10.1007/s10734-008-9128-2.

Jong-Wha, L. E. E., & Wie, D. (2017), "Wage structure and gender earnings differentials in China and India", *World Development*, Vol. 97, pp.313-329.

Joshi, K. (2010). "Higher education and the largest impoverished and marginalized group of the Indian population: reviewing enrolment and access to higher education among tribals in India", *Asian Social Work and Policy Review*, Vol. *4*, *No.*2, pp.57-65.

Joshi, K. M. (2015). "Higher education, social demand, and social equity in India", In *Higher Education in the Brics Countries: Investigating the pact between higher education and society*, pp. 125-147. Dordrecht: Springer Netherlands.

Joshi, K. M., & Ahir, K. V. (2019). "Higher Education in India: Issues related to Access, Equity, Efficiency, Quality and Internationalization.", *Academia*, Vol. 14, pp. 70-91.

Kakkar, G. (2020). “Opportunities and challenges for girl child schooling and education in India.”, *IJCRI-International journal of Creative Research & Innovation*.

Kapur, R. (2019). “Problems and Educational Needs of Muslim Women” Acta Scientific *Women's Health* Vol. 1, No. 7, pp.1-10

Kargarmoakhar, M., & Ross, M. S. (2019). “How cultural messages through experiences influence occupational pursuit of Muslim female computer science students”, In *2019 ASEE Annual Conference & Exposition*, pp.1-8.

Kasi, A. M. J., Shah, S. H., & Kakar, M. A. (2021). “The relationship between Higher Education, Women Earning and Socio-Economic Status, Quetta-Pakistan.”, *Journal of Education and Humanities Research (JEHR), University of Balochistan, Quetta*, Vol. 11, No. 1. pp.35-46.

Khan, J. and Butool, F. (2013). “Education and development of Muslims in India: A comparative study”. *IOSR Journal of Humanities and Social Science (IOSR-JHSS)*, Vol. 13, No. 2, pp. 80-86.

Khan, K. (2015). “Disparities in access to higher education in India.”, *Journal of Social Inclusion Studies*, Vol. 1, No. 2. pp. 168-178.

Khanum, S., & Hussain, T. (2022). “Indian Muslims’ Socio-Political and Economic Challenges in the Globalised World.”, *Strategic Studies*, Vol. 42, No. 3. pp. 87-106.

Khatoon, F. (2022). “Disparity in Access to Higher Education among Socio-Religious Groups in Urban India: An Analysis of Household Survey Data”, *Journal of Positive School Psychology*, pp.911-924.

Khatsrinova, O., Khatsrinova, J., & Bronskaya, V. (2020, September). “Realization of elite education at engineering higher education institution.”, In *International Conference on Interactive Collaborative Learning*, pp. 13-29. Cham: Springer International Publishing.

Khattab, N. (2016). “The ethno-religious wage gap within the British salariat class: How severe is the penalty?”, *Sociology*, Vol. 50, No. 4. pp. 813-824.

Kim, L., Smith, D. S., Hofstra, B., & McFarland, D. A. (2022). “Gendered knowledge in fields and academic careers.”, *Research Policy*, Vol. *51, No.* 1, pp.104411.

Kim, N. (2023). “Education of Muslim Minorities in India”, pp. 81-97. doi: 10.4324/9781003370222-9

Konyeha, S., Agwam, G. I., Musa, E., Ngonadi, I. V., & Afehomo, A. C. (2021). “Initiatives and role of women scientist forums with mentorship opportunities in STEM.”, *African Journal of Health, Safety and Environment*, Vol. 2, No. 2, pp. 89-99.

Kotay, F.A. (2013). “Educational Exclusion of Indian Muslims: Issues and Problems”. *European Academic Research*, Vol. 1, No. 9, pp. 2843-2866.

Kromydas, T. (2017). “Rethinking higher education and its relationship with social inequalities: past knowledge, present state and future potential.”, *Palgrave communications*, Vol.3, No.1, pp.1-12.

Kumar, A. (2021). "Educational Inequalities in India", International *Journal of Law Management and Humanities,* Vol. 4, No. 5, pp.1476 – 1484.

Kumar, A., & Hashmi, N. I. (2020). "Labour market discrimination in India.", *The Indian Journal of Labour Economics*, Vol. *63, No.* 1, pp. 177-188.

Kumar, A., & Sahoo, S. (2024). "Caste, gender, and intersectionality in stream choice: evidence from higher secondary education in India.", *Education Economics*, Vol. *32, No.* 1, pp. 20-46.

Kumar, A., & Shukla, S. K. (2022). "Affordable housing and the urban poor in India. *Social Change"*, Vol. *52, No.* 1, pp.58-75.

Kumar, D. (2021). "Journey with Rural Identity and Linguicism.", *CASTE: A Global Journal on Social Exclusion*, Vol. *2, No.* 1, 202-218.

Kumar, D., Pratap, B., & Aggarwal, A. (2020). "Affirmative action in government jobs in India: Did the job reservation policy benefit disadvantaged groups?", *Journal of Asian and African Studies*, Vol. 55, No. 1, pp. 145-160.

Kumar, N. (2016). "Impact of Parental Socio-Economic Factors on the Performance of Students in IIT-JEE.", Current Science, Vol. 110, No. 11, pp. 2079-2081. doi: 10.18520/CS/V110/I11/2079-2081.

Kumar, S. (2022). "Demystifying the Myths Associated with Caste-Based Reservation.", *Contemporary Voice of Dalit*, 2455328X221101682.

Kumar, S. M. (2018). "Comparing private and government schools in India: The devil is in the maths.", *Applied Economics Letters*, Vol. *25, No.* 6, 409-414.

Kundu, A. (2015, Sep-07). "Muslims constitute 14% of India, but just 3% of India Inc", The Economic Times.

Kushwaha, -., K. A., -. (2023). "Relationship between Academic Achievements and Ethical Consideration in Research.", *International Journal for Multidisciplinary Research*, Vol. 5, No. 2. doi: 10.36948/ijfmr. 2023.v05i02.1740.

Kyere, E., Hong, S., & Gentle-Genitty, C. S. (2023), "Mediational effect of teacher-based discrimination on academic performance: An intersectional analysis of race, gender, and income/Class". *Education Sciences,* Vol.*13, No.*4, p.387.

Lama, S., & Majumder, R. (2018). "Gender inequality in wage and employment in Indian labour market.", *Journal of Academic Research in Economics*, Vol. 10, No. 3. pp. 1-26.

Lang, K. and Manove, M. (2011), "Education and Labor-Market Discrimination", American Economic Review, Vol. *101, No.* 4,1467-96.

Lanzarini, L., Charnelli, M. E., & Díaz, J. (2015, October). "Academic performance of university students and its relation with employment.", In *2015 Latin American Computing Conference (CLEI)*, pp. 1-6. IEEE.

Laskowska, I., & Dańska-Borsiak, B. (2016). "The importance of human capital for the economic development of EU regions.", *Comparative Economic Research. Central and Eastern Europe,* Vol. *19, No.* 5, pp. 63-79.

Li, I. W. and Miller, P. W. (2012), "Gender Discrimination in the Australian Graduate Labour Market", Australian *Journal of Labour Economics,* Vol.15, No. 3, pp.167-199.

Li, I. W., Jackson, D., & Carroll, D. R. (2023). "Influence of equity group status and entry pathway on academic outcomes in higher education.", *Journal of Higher Education Policy and Management,* Vol. 45, No. 2. pp. 140-159.

Linando, J. A. (2024). "Employment struggles for Muslims: A systematic review.", *Journal of management, spirituality & religion,* Vol. 21, No. 1. pp. 1-41.

Lisiswanti, R. (2022). "Factors Affecting Low Academic Achievement of Undergraduate Medical Students: Student Experience." *Jurnal Pendidikan Kedokteran Indonesia-The Indonesian Journal of Medical Education,* Vol. 11, No. 1. pp.108-188.

Livanos, I., Yalkin, C. and Nunez, I. (2009), "Gender employment discrimination: Greece and the United Kingdom", *International Journal of Manpower,* Vol .30, No. 8, pp. 815-834.

Lopez, P. D. J., & Duran, A. (2021). "The role of mentoring on the retention of women from diverse backgrounds in STEM.", In *Implementation Strategies for Improving Diversity in Organizations,* pp. 271-310. IGI Global.

López-Pérez, M.F., Larrubia, M.Á., Fernández, A. and Sempere, J., (2023), "Overview of the current situation relating to chemical engineering degree courses", *Education for Chemical Engineers,* Vol. *43,* pp.73-82.

Loyalka, P., Carnoy, M., Froumin, I., Dossani, R., Tilak, J. B. and Yang, P. (2014), "Factors affecting the quality of engineering education in the four largest emerging economies", *Higher Education,* Vol.68 No.6, pp. 977-1004.

Lynch, M. (2016). "Examining the impact of culture on academic performance", Pennsylvania: Routledge.

Madheswaran, S. and Attewell, P. (2007), "Caste Discrimination in the Indian Urban Labour Market: Evidence from the National Sample Survey", Economic and Political Weekly, Vol. 42, No. 41, pp. 4146-4153.

Maduwanthi, W. T. S., Mudalige, S. K. K., & Atapattu, N. S. B. M. (2016). "Academic performance and the perception about the educational environment: A comparison between ethnic minority and majority students following three-degree programs", Tropical Agricultural Research and Extension, Vol. 18, No. 3. pp. 107. doi: 10.4038/TARE.V18I3.5333

Mahadevaswamy,M., Sajan, C.P , and Kotreshwar,G., (2013). "Perception of SC/ST students participating in higher education with special reference to Mysore, Karnataka", IOSR Journal of Economics and Finance, Volume 1, Issue 4, pp.39-42.

Maji, K., & Sarkar, S. (2018). "Comparative Analysis of Educational Attainment among Different Social Groups in Some Selected Mouzas of Saltora CD Block of Bankura

District, West Bengal, India: An Empirical Study." *Space and Culture, India*, Vol. 6, No. 1, 72-90.

Major, J., & Godwin, A. (2018, October). "Towards making the invisible engineer visible: a review of low-socioeconomic students' barriers experiencing college STEM education." In *2018 IEEE Frontiers in Education Conference (FIE)*, pp. 1-9. IEEE.

Malhotra, P., & Shekhar, C. (2013). "Locus of control and parenting styles as correlates of academic performance in socially disadvantaged undergraduate students", *International Journal of Education and Management Studies*, Vol. 3, No. 3, pp.320.

Malik, A. (2023). "Educational Experiences and Aspiration of Muslim Women in India: Issue and Challenges.", *Journal of Social Inclusion Studies*, Vol. 9, No. 1. pp. 61-81.

Malish, C. M., & Ilavarasan, P. V. (2016). "Higher education, reservation and scheduled castes: Exploring institutional habitus of professional engineering colleges in Kerala.", *Higher Education*, Vol. *72*, pp. 603-617

Malkogeorgou, S., & Duffy, G. (2022). "The influence of gender stereotypes on women's spatial abilities and their underrepresentation in the field of engineering.", *In Towards a new future in engineering education, new scenarios that european alliances of tech universities open up*, pp. 2059-2065. Universitat Politècnica de Catalunya.

Mamo, H., Gosa, G. and Hailu, B. (2017), "Perception of University Female Students on Factors Affecting Their Academic Performance and Competency: A Study from Dire Dawa University, Ethiopia", Science *Journal of Education*, Vol. 5, No. 5, pp. 211-215.

Manikandan, A. and Muthumeenakshi, M. (2018), "Role of Engineering Education in Sustaining the *Economic Development of India*", IJMET, Vol. 9, No. 3, pp. 706–710.

Manjunath, D. R. (2021). "The Impact of Academic Performance on Employability–A Study", PalArch's *Journal of Archaeology of Egypt/Egyptology*, Vol. 18, No.10, pp. 508-517.

Marginson, S., 2018. "Higher education, economic inequality and social mobility: Implications for emerging East Asia.", *International Journal of Educational Development*, Vol. 63, pp.4-11.

McCafferty, H. (2022). "An unjust balance: a systematic review of the employability perceptions of UK undergraduates from disadvantaged socio-economic backgrounds." *Research in Post-Compulsory Education*, Vol. 27, No. 4, pp. 570-593

McCann, M., & Hewitt, M. (2023). "Academic performance and work placements: does academic performance influence the decision to complete a work placement?", *Higher Education, Skills and Work-Based Learning*, Vol. *13, No.*1. pp. 97-112.

Melak, A. and Singh, S. (2021), "Women's Participation and Factors Affecting Their Academic Performance in Engineering and Technology Education: *A Study of Ethiopia", Sustainability*, Vol. 13, No. 4, p.2246.

Merayo, N., & Ayuso, A. (2023). "Analysis of barriers, supports and gender gap in the choice of STEM studies in secondary education.", *International Journal of Technology and Design Education*, Vol. 33, No. 4. pp. 1471-1498.

Mersha, Y., Bishaw, A. and Tegegne, F. (2013), "Factors Affecting Female Students' Academic Achievement at Bahir Dar University", *Journal of International Cooperation in Education,* Vol. 15, No. 3, pp.135 – 148.

Midya, D. K., & Islam, M. M. (2024). "Gender Discrimination in Education among the Muslims: A Case Study in an Indian Village for Identifying the Key Factors.", *Journal of Asian and African Studies,* Vol. 59, No. 1. pp. 274-291.

Mir, S. A., & Pramanik, S. (2017). "Socio-religious affiliation and higher education participation of Muslim minorities in India: a probit analysis.", *Journal of Social and Economic Development,* Vol. 19, No. 2. pp. 365-386.

Mitra, A., & Murayama, M. (2009). "Rural to urban migration: A district-level analysis for India.", *International Journal of Migration, Health and Social Care,* Vol. *5, No.* 2, 35-52.

Mohanan, S. M., & Netto, S. G. (2023). "Person Perception of Students on Reservation in Higher Education in India.", *Contemporary Voice of Dalit,* 2455328X231169201.

Moinifar, H.S. (2012), "Higher education of women in Iran: progress or problem?", *International Journal of Women's Research*, Vol. 1, No. 1, pp. 43-60.

Mollah, K., & Bera, S. (2018). "Status of Muslim Education in India: "Problems and Concerns" ", Aarhat Multidisciplinary International Education Research Journal (AMIERJ), Vol VII, Issues No. I, pp.213-223.

Morley, L. (2006), "Including Women: Gender in Commonwealth, Higher Education", *Women's Studies International Forum*, Vol. 6, No. 29, pp. 539-542.

Munir, J., Faiza, M., Jamal, B., Daud, S., & Iqbal, K. (2023). "The Impact of Socio-economic Status on Academic Achievement.", *Journal of Social Sciences Review*, Vol. *3, No.* 2, pp. 695-705.

Munusamy, K. (2022). "*The legal basis for affirmative action in India"* (No. 2022/74). WIDER Working Paper, doi: 10.35188/unu-wider/2022/205-8

Narula, M. (2014). "Educational development of Muslim minority: With special reference to Muslim concentrated states of India.", *Journal of Education and Research,* Vol. 4, No. 1. pp. 93-108.

Narwana, K., & Gill, A. S. (2020). "Beyond access and inclusion: Dalit experiences of participation in higher education in rural Punjab", *Contemporary Voice of Dalit,* Vol. 12, No. 2, pp.234-248.

Nato, P. B. (2016). "Analysis of family structure influence on academic performance among secondary school students in Bungoma East Sub-County, Kenya.", *International Journal of Secondary Education*, Vol. *4, No.* 2, pp. 12-22.

Nazari, S. (2022). "Employment income gap in the Canadian labour market: Intersection of gender, religion and visible minority status." *Journal of Muslim Minority Affairs*, Vol. 42, No. 2. pp.179-197.

Nazimuddin, S.K., 2015. “Social mobility and role of education in promoting social mobility.”, *International Journal of Scientific Engineering and Research*, Vol. 3, No.7, pp.176-179.

Neally, K. (2022). “An analysis of the underrepresentation of minoritized groups in science, technology, engineering, and mathematics education.”, *School Science and Mathematics*, Vol. *122, No.* 5, pp. 271-280.

Neog, M.P., (2018). “A Study of the Socio-Economic Problems of Scheduled Caste Students in *Higher Education Special Reference to Assam*”, IJESC, Vol. 8, No.3.

NEP. (2020). “National Education Policy”, Ministry of Human Resource Development (MHRD),Government of India, https://www.education.gov.in/sites/upload_files/mhrd/files/NEP_Final_English_0.pdf.

Ngqondi, T., & Mauwa, H. (2019, August). “A review of digital integration for high school curriculum.”, In *2019 International Conference on Advances in Big Data, Computing and Data Communication Systems (icABCD)*, pp. 1-6. IEEE.

Noor, A. F. (2016). “Minority Education| A study of Indian Muslims”, *SOCRATES*, Vol.*4, No.*1, pp. 52-60.

Noor, A.F. (2016). “Minority Education A study of Indian Muslims.”, SOCRATES: An International, Multi-lingual, Multi-disciplinary, refereed (peer-reviewed), Indexed *Scholarly journal*, Vol. 4, No. 1, pp. 52-60.

Noorjahan, a. (2023). “Educational backwardness of women among muslim minority: ananalytical study.”, *International journal of advanced research*, Vol. 11, No. 2. pp.1182-1191. doi: 10.21474/ijar01/16364

Nusselder, F., Armstrong, A., Giovannangeli, A., Burrows, H., & Xu, Y. (2023, March). “Addressing Financial Barriers to Higher-Education.” In *Inquiry@ Queen's Undergraduate Research Conference Proceedings*, Vol. 17.

Olson, K. (2019), “Impact of parent mentoring and participation in FIRST robotics on middle and high school age female perceptions of engineering careers”.

Olufemi, O.T., Adediran, A.A. and Oyediran, W.O. (2018). “Factors affecting students’ academic performance in colleges of education in Southwest, Nigeria”. *British Journal of Education*, Vol. 6, No. 10, pp. 43-56.

Ononye, L., & Bong, S. (2018). “The Study of the Effectiveness of Scholarship Grant Program on Low-Income Engineering Technology Students.”, Journal *of STEM Education*, Vol. 18, No. 5.

Oplatka, I. and Lapidot, O. (2012). “Muslim women in graduate studies: some insights into the accessibility of higher education for minority women students”, *Studies in Higher Education,* Vol.37, No.3, pp.327-344.

Owens, T. L. (2017). “Higher education in the sustainable development goals framework”,

Pager, D., & Shepherd, H. (2008). “The sociology of discrimination: Racial discrimination in employment, housing, credit, and consumer markets.”, *Annu. Rev. Social*, Vol. 34, pp. 181-209.

Pai, S. (2000). “Changing socio-economic and political profile of scheduled castes in Uttar Pradesh”, Journal of Indian School of Political Economy, Vol. 12, No. 3, 419.

Panakaje, N. (2022). “Approaches towards Education Upliftment of Religious Minority: An Analysis of Central Government Schemes.”, *International Journal of Case Studies in Business, IT and Education (IJCSBE)*, Vol. 6, No. 2. pp. 624-636.

Parihar, K. S., Dahiya, R., Billaiya, R., & Jain, P. (2017). “Effect of nuclear family in participation of activities.”, *International Journal of Health Sciences (IJHS)*, Vol. *1, No.*1, pp. 28-35.

Pathania, G., Jadhav, S., Thorat, A., Mosse, D., & Jain, S. (2023). “Caste Identities and Structures of Threats: Stigma, Prejudice and Social Representation in Indian universities.”, *CASTE: A Global Journal on Social Exclusion*, Vol. 4, No. 1, 3-23.

PATIL, P. (2021). “Caste in Higher Education: Examining and Redefining Affirmative Action”, A Journal of The Yif Critical Writing Programme, 4.

Patterson, L., Varadarajan, D. S. and Salim, B. S. (2021), “Women in STEM/SET: gender gap research review of the United Arab Emirates (UAE)–a meta-analysis”, *Gender in Management: An International Journal*, Vol.36, No. 8, pp. 881-911.

Paul, M. and Das, C.C. (2020). “Problems of Muslim girls in higher education in Hojai district: a pilot study”. *Journal of Natural Remedies*, Vol. 21, No. 6, pp. 11-17.

Pearson Jr, W., & Miller, J. D. (2012). “Pathways to an engineering career.”, *Peabody Journal of Education*, Vol. *87, No.* 1, pp. 46-61.

Plasman, J. S., Gottfried, M., & Williams, D. (2021). “Following in their footsteps: The relationship between parent STEM occupation and student STEM course taking in high school.”, *Journal for STEM Education Research*, Vol. 4, No. 1, pp. 27-46.

Powell, A., Bagilhole, B. and Dainty, A. (2009), “How Women Engineers Do and Undo Gender: Consequences for Gender Equality*”, Gender, Work and Organization*, Vol.16, No.4, pp. 411-428.

Price, E.A., White, R.M., Mori, K., Longhurst, J., Baughan, P., Hayles, C.S., Gough, G. and Preist, C. (2021). “Supporting the role of universities in leading individual and societal transformation through education for sustainable development.”, *Discover Sustainability*, Vol. 2, No. 1, p.49.

Psacharopoulos, G., & Patrinos, H. A. (2018). “Returns to investment in education: a decennial review of the global literature”, *Education Economics*, Vol. 26, No. 5, pp. 445-458.

Qamar, F. and Shamra, N. (2021, Oct-05). “More Muslim representation needed in higher education”. *Deccan Herald*.

Rahaman, S. (2021). “Gradual Streaming of Education Among Scheduled Caste and Scheduled Tribe in Jharkhand: Role of Reservation Policy”, *International Journal of Current Research,* Vol. 13, No.1, pp.15786-15792.

Rahim-Dillard, S., & Johnson, S. K. (2023). “Inclusive leadership is key to creating equity for women of color.”, In *A Research Agenda for Gender and Leadership,* pp. 155-173. Edward Elgar Publishing, doi: 10.4337/9781800883826.00014

Raja, A. M., Raju, R., Sriramadesikan, B., Surendhar, M., Darvin Rajesh, J., Thilippan, P., & Raja, D. S. (2021). “Predictors of academic performance among girls in south Indian cities.”, *SN Social Sciences*, Vol. 1, No. 10. pp.1-19.

Ramirez, F.O. and Wotipka, C.M. (2001), “Slowly but Surely? The Global Expansion of Women's Participation in Science and Engineering Fields of Study, 1972-92”, *Sociology of Education*, Vol. 74, No. 3, pp. 231-251.

Rani, P. G. (2013). “Exploring earnings and education disparities in India across region, caste, religion and English language ability.”, *Artha Vijnana: Journal of The Gokhale Institute of Politics and Economics*, Vol. 55, No. 4. pp.402-420.

Rashmi, R., Malik, B. K., Mohanty, S. K., Mishra, U. S., & Subramanian, S. V. (2022). “Predictors of the gender gap in household educational spending among school and college-going children in India.”, *Humanities and Social Sciences Communications*, Vol. 9, No. 1. pp. 1-11.

Rathod, B. (2019). “Caste conflicts on campuses: Examining diversity research to transform Indian universities into inclusive learning spaces”, *Journal of Social Inclusion Studies*, Vol. 5, No. 2, pp. 129-146.

Rathod, C. H. (2023). “A Study of Problems of Secondary School Students in the Context of their Caste and Area.”, *International Journal of Management and Development Studies*, Vol. 12, No. 5, pp. 19-25.

Ray Chaudhury, A., Sarkar, S., & Sinha, M. (2023). “Disparity in Educational Participation in the Lenses of Educational Returns and Family Background: Evidence from India.”, *Journal of Asian and African Studies*, doi: 10.1177/00219096231158342.

Razak, W.A.I.W.A., Akmal, S. N. A. K., Azizan, N.F., Wani, S., Hamal, A. Q., & Muhammad, A., (2021). “Factors Affecting Student’s Academic Performance.”, Vol. 7, No. 1. pp. 99-107.

Rekha, P. (2006). “Muslim Women and Girl’s Education: A Case Study from Hyderabad”. *Journal of Indian Education,* Vol. XXXII, No. 1, pp.80-95.

Richardson, B. C., & Dinkins, E. G. (2014). “Life on the Reservation: Cross-Cultural Field Experiences and Student Learning.”, *AILACTE Journal*, Vol. 11, No. 1, pp. 57-72.

Riegle-Crumb, C. and Moore, C. (2013), “Examining gender inequality in a high school engineering course’ American *Journal of Engineering Education,* Vol. 4, No.1, pp. 1-16.

Riks, M., Schaefer, C., & Brockmann, P. (2022, May). “Challenges to Increasing Diversity in Engineering Education During the Covid-19 Pandemic: Specific Problems Encountered

by Students from Underrepresented Groups.", In *2022 45th Jubilee International Convention on Information, Communication and Electronic Technology (MIPRO)*, pp. 1284-1288. IEEE.

Ritz, J. M., & Bevins, P. S. (2012). "Economics, innovations, technology, and engineering education: The connections", Economics, Vol.38, No.2.

Robinson. R. (2016). "Religion, Socio-economic Backwardness & Discrimination: The Case of Indian Muslims.", *The Indian Journal of Industrial Relations*, Vol. 44, No. 2. pp.194-200.

Sabharwal, N. S. (2021). "Nature of access to higher education in India: emerging pattern of social and spatial inequalities in educational opportunities.", *Reflections on 21st Century Human Habitats in India: Felicitation Volume in Honour of Professor MH Qureshi*, pp. 345-369.

Sabharwal, N. S., & Malish, C. M. (2018). "Student diversity and social inclusion: An empirical analysis of higher education institutions in India", CPRHE Research Paper, 10.

Sahoo, P., & Das, S. K. (2019). "Manufacturing engineering education—Indian perspective", In *Manufacturing engineering education* pp. 31-72, Chandos Publishing.

Saif, E., & Kumar, A. (2023). "Minority women empowerment through government and non-government organization.", *Journal of Women Empowerment and Studies*, Vol. *32*, pp: 7-16.

Saleem, M.O. (2021). "A Pilot Study: Education among Muslims of Jamia Nagar, Okhla, New Delhi", International Journal for Research in Applied Science & Engineering Technology (IJRASET), Vol. 9, No. IX.

Saleh, M. (2019). "Socioeconomic Inequality Across Religious Groups: Self-Selection or Religion-Induced Human Capital Accumulation? The Case of Egypt.", *Advances in the Economics of Religion*, pp. 283-294.

Samraj, C. J. (2022). "Manifestations of Academic Untouchability in India.", *CASTE: A Global Journal on Social Exclusion*, Vol. 3, No. 2, pp. 442-457.

Sanders, S. L., & Orbe, M. P. (2017). "TIPs to Maximize Meaningful Professional Development Programs and Initiatives: A Case Study in Theoretically-Grounded Diversity Education.", *In Discrimination and Diversity: Concepts, Methodologies, Tools, and Applications*, pp. 593-615. IGI Global.

Sankaran, S., Sekerdej, M., & Von Hecker, U. (2017). "The role of Indian caste identity and caste inconsistent norms on status representation", Frontiers *in psychology*, Vol.*8*, p.487.

Sardoč, M. (2022). "The trouble with merit.", *Theory and Research in Education*, Vol. 20, No. 2. pp. 135-144.

Sarkar, P. K. (2023). "Scheduled tribes (ST) students: Challenge & development.", *Brazilian Journal of Science*, Vol.*2, No.*10, pp. 86-91.

Schotte, S., Leone, T., & Gisselquist, R. M. (2023). "*The impact of affirmative action in India and the United States: A systematic literature review* (No. 2023/15)."' WIDER Working Paper, doi: 10.35188/unu-wider/2023/323-9

Schreuders, P. D., Mannon, S. E. and Rutherford, B. (2009), "Pipeline or personal preference: women in engineering", European *Journal of Engineering Education*, Vol. 34, No. 1, pp. 97–112.

Selvarajoo, P. C. B., & Baharudin, S. N. A. (2023). "Factors Contributing to Poor Academic Achievement among Underachieving Students in A High School in Klang Valley: A Case Study.", *Journal of Academic Research in Business and Social Sciences*, Vol. 13, No. 4. pp. 1986-1997.

Sencan, H., & Karabulut, A. T. (2015). "Monitoring of Educational Performance Indicators in Higher Education: A Comparison of Perceptions.", *Educational Sciences: Theory and Practice*, Vol. *15, No.* 2, pp. 359-376.

Şengönül, T. (2022). "A review of the relationship between parental involvement and children's academic achievement and the role of family socioeconomic status in this relationship.", *Pegem Journal of Education and Instruction*, Vol. *12, No.* 2, pp. 32-57.

Sengupta, R., & Rooj, D. (2018). "Factors affecting gender disparity in Muslim education in India.", *Journal of Development Policy and Practice*, Vol.3, No. 1, pp. 87-113.

Sethuraman, V. (2023). "Does Economic Basis of Reservation Weaken Constitutionalism in India?", *Contemporary Voice of Dalit*, 2455328X231168546.

Shah, G. (1991). "Social backwardness and politics of reservations", Economic and Political Weekly, pp. 601-610.

Shah, M. (2017). "Understanding Education and Its Role in Empowerment.", *Economic and Political Weekly*, Vol.52, N0.13, pp. 33-36.

Shariff, A. (2023). "Effecting Equity and Equality of Opportunity in a Socially Diverse India.", *Social Change*, Vol. 53, No. 1. pp. 108-116.

Sharma, A. (2022). "Impact of Reservation Policy in Higher Education: An Investigation.", *International Journal of Social Ecology and Sustainable Development (IJSESD)*, Vol. 13, No. 6, pp. 1-14.

Sharma, K. K. (2022). "Impacts of Caste Based Reservation System on the Lives of Scheduled Caste Engineers in India: A Case Study."

Sharma, M. (2016). "Women education: need for sustainable development.", *Global Journal of Human-Social Science*, Vol. 16, No. 1. pp.23-25.

Sharmin, V. G., Sharmina, T. N., & Sharmin, D. V. (2022). "Identifying the degree of influence of various factors on students' academic performance based on their self-assessment, taking into account students' gender.", *Science for Education Today*, Vol. 12, No. 3, pp. 92-114.

Shazli, T., and Asma, S. (2015). "Educational vision of Muslims in India: Problems and concerns.", International Journal of Humanities and Social Science Invention, Vol. 4, No. 3. pp. 21-27.

Shi Y. (2018), "The puzzle of missing female engineers: Academic preparation, ability beliefs, and preferences", *Economics of Education Review*, Vol. 64, pp. 129-143.

Siddique, M., Baig, M., & Munir, M. M. (2021). "Female Education Supports in Up-Gradation of A Society: An Investigation from Female Primary School Teachers In District Malir, Karachi.", *Pakistan Journal of Gender Studies*, Vol. 21, No. 2. pp. 73-92.

Silbey, S. S. (2016), "Why do so many women who study engineering leave the field", *Harvard Business Review*, Vol. 23, pp.1-8.

Silva, D. N., Silva, W. D. O., & Fontana, M. E. (2023, May). "A gendered perspective of challenges women in engineering careers face to reach leadership positions: A innovative theoretical model from Brazilian students' perceptions.", *In Women's Studies International Forum*, Vol. 98, pp. 102712. Pergamon.

Singh, A. (2014). "Who Have Access in Engineering Education", International *Journal of Innovative Social Science & Humanities Research*, Vol. 1, No. 1, pp.68-72.

Singh, A. and Singh, S. (2018), "Expansion of Private Engineering Institutions: Challenges Ahead*", Higher education for the future*, Vol.5, No.1, pp.20-39.

Singh, A.J, and Singh, S.R. (2023), "Pradhan Mantri Awas Yojana (PMAY): Government of India's Approach to Affordable Housing for the Urban Poor", Journal of Advanced Zoology, Vol.44, No. 5, pp. *3098-3108.*

Singh, H. (2023). "Does labour market discriminate against the scheduled castes?", Empirical evidence from rural Punjab, India. *Millennial Asia*, 09763996221140268.

Singh, N. (2007). "Higher Education for Women in India--Choices and Challenges", In Forum on Public Policy Online, Vol. 2007, No. 1, p. n1.

Singh, S. (2012). "Accessibility of Engineering Education for Muslim Community in India." Quality Concern *in Higher Education*, Centre for Social Research and Development, Pune, pp. 119-131, ISBN- 978-81-910455-1-3.

Singh, S., & Fenton, E. S. L. (2014). "Women engineers: A comparative study between India and Australia.", *International Journal of Advancements in Research & Technology*, Vol. *3, No.*7, pp. 108-122.

Solnik, M. (2017). *"Contributing Factors to the Under-Representation of Women in Undergraduate Engineering"* (Doctoral dissertation).

Sönmez, T., & Yenmez, M. B. (2019). "*Affirmative action in India via vertical and horizontal reservations"* , No. 977. Boston College Department of Economics.

Srivastava, R. (2019). “Emerging dynamics of labour market inequality in India: Migration, informality, segmentation and social discrimination.”, *The Indian Journal of Labour Economics,* Vol. 62, No. 2. pp. 147-171.

Stephan, P.E. (1996), “The economics of science”, *Journal of Economic Literature,* Vol. 34, No.3, pp. 1199-1235.

Stevenson, J., Demack, S., Stiell, B., Abdi, M., Ghaffar, F., & Hassan, S. (2017). “The social mobility challenges faced by young Muslims.”

Stewart, C. A. (2021), “Underrepresentation of Women STEM Leaders: Twelve Women on Different Journeys Using Their Voices to Shape the World through Science”, European *Journal of STEM Education*, Vol. 6, No. 1, pp.16.

Subheesh, N. P., Ayisha, E. A., Akash, V., Akshay, R. S., Sarath, S., & Yadhukrishna, K. (2023, May). “Gender Differences in School Students' Perceptions Towards Engineering: A Case Study from Rural South India.”, *In 2023 IEEE Global Engineering Education Conference (EDUCON),* pp. 1-6. IEEE.

Subramanian, A. (2019). “*The caste of merit: Engineering education in India*.” Harvard University Press.

Subramanian, B., (2015), “Engineering education in India: a comprehensive overview”, International *Perspectives on Engineering Education: Engineering Education and Practice in Context, Vol. 1*, pp.105-123.

Sudan, F. K. (2013). “Tapping Talents in India Through the Diaspora Network: Opportunities and Challenges.”, *Global Diasporas and Development: Socioeconomic, Cultural, and Policy Perspectives,* pp. 221-236.

Sukumar, N. (2022). “Caste Discrimination and Exclusion in Indian Universities: A Critical Reflection (1st ed.).”, Routledge India. https://doi.org/10.4324/9781003095293

Sunar, G. B. (2022). “Against Dalits Reservation: Exploring the Views of So-Called Upper Caste Students Studying at Kailali Multiple Campus, Dhangadhi.”, *Sociology Mind*, Vol.*12, No.*2, pp. 58-75.

Swarup, A. and Dey, T. (2020), “Women in science and technology: an Indian scenario”, Current science, Vol.119, No.5, pp. 744-748.

Tangnu, S., & Sharma, A. (2012, November). “Women engineers-perceptions, apprehensions, and life transitions.”, *In TENCON 2012 IEEE Region 10 Conference*, pp. 1-6. IEEE.

Tariq, M., & Syed, J. (2018). “An intersectional perspective on Muslim women's issues and experiences in employment.”, *Gender, Work & Organization*, Vol. 25, No. 5. pp. 495-513.

Taylor, D. (2007), “Employment Preferences and Salary Expectations of Students in Science and Engineering”, Bio Science, Vol. 57, No. 2, pp. 175-185.

Tentama, F., & Abdillah, M. H. (2019). "Student Employability Examined from Academic Achievement and Self-Concept", International *Journal of Evaluation and Research in Education,* Vol. 8, No. 2, pp.243-248.

Terziev, V. (2022). "The role of education in socialization of an individual", *IJAEDU-International E-Journal of Advances in Education,* Vol.*8, No.* 22, pp.70-75.

Thiry, H. (2019). "Issues with high school preparation and transition to college." *Talking about Leaving Revisited: Persistence, Relocation, and Loss in Undergraduate STEM Education,* pp.137-147.

Thomas Asha E. & M. Bhasi (2018). "Investment in Higher Education Sector of India: A Review of Related Literature and Preliminary Investigation." International Journal of Management Studies, Vol. 5, No. 2, pp. 47-62.

Thorat, S. (2022). "Ambedkar's Solution Against Communal Majority.", In *Politics of Representation: Historically Disadvantaged Groups in India's Democracy.* pp. 81-100. Singapore: Springer Nature Singapore.

Thorat, S. (2022, Jan-10). "Muslims have lowest GER in higher education", Times of India.

Thorat, S., & Ahmad, M. (2015). "Minorities and poverty: Why some minorities are more poor than others?", *Journal of Social Inclusion Studies,* Vol. 1, No. 2. pp. 126-142.

Tierney, W. G., Sabharwal, N. S., & Malish, C. M. (2019). "Inequitable structures: Class and caste in Indian higher education." *Qualitative Inquiry,* Vol. 25, No. 5, pp. 471-481.

Tilak, J. B. (2021). "Students' perspectives on quality of engineering education in India", *Journal of Applied learning and Teaching,* Vol. *4,* No.1, pp.56-71.

Tilak, J.B. and Choudhury, P.K. (2021). "Paradoxes and Contradictions in the Growth of Engineering Education in India: Challenges and Prospects" Available at SSRN 3880957.

Tilak, J.B.G. (2020). "Engineering graduates in India: Determinants of their employment and earnings." *Higher Education Governance & Policy,* Vol. 1, No. 2, pp. 76-98.

Tiruneh, W. A. and Petros, P. (2014), "Factors Affecting Female Students' Academic Performance at Higher Education: The Case of Bahir Dar University, Ethiopia", *African Educational Research Journal,* Vol. 2, No. 4, pp. 161-166.

Tuicu, L. and Simko, J. (2015). "Determinants of human capital: A study on Swedish municipalities".

Tzafea, O. (2023). "Inequalities in higher education students' academic performance.", International journal for innovation education and research, Vol. 11, No. 4. pp. 11-23. doi: 10.31686/ijier.vol11.iss4.4097

Unterhalter, E., & Howell, C. (2021). "Unaligned connections or enlarging engagements? Tertiary education in developing countries and the implementation of the SDGs", *Higher Education,* Vol. *81,* pp.9-29, https://doi.org/10.1007/s10734-020-00651-x.

Ur Rehman, U., Amin, F., & Abbas, S. M. (2020). "The Influence of Insecurity on Economic Deprivation of The Minorities in Khyber Pakhtunkhwa, Pakistan.", *Gomal University Journal of Research,* Vol. 36, No. 2 pp. 14-24.

Utami, A.Y. (2022). "The Role of Parental Involvement in Student Academic Outcomes.", Journal of Education Review Provision, Vol. 2, No. 1, pp.17-21. doi: 10.55885/jerp. v2i1.156

Vadivel, B., Alam, S., Nikpoo, I., & Ajanil, B. (2023). "The Impact of Low Socioeconomic Background on a Child's Educational Achievements.", *Education Research International,* 2023, pp. 1-11. doi: 10.1155/2023/6565088

Valero, M. (2022). "Challenges, Difficulties and Barriers for Engineering Higher Education", *Journal of Technology and Science Education,* Vol. *12, No.* 3, pp.551-566.

Varghese, P., & Jose, J. (2023). "Affirmative Action and New Populism", pp.1-6. doi: 10.1007/978-981-16-9859-0_144-1

Veeresha, N. (2022). "Politics of Reservation: Implications for Social Justice.", *Indian Journal of Human Development,* Vol. 16, No. 2. pp. 385-389.

Verma, A. (2013). "Caste-education syndrome: Impact of reservations on institutions of higher education", International *Journal of Social Science & Interdisciplinary Research,* Vol. 2, No. 6, pp.139-146.

Vijayan, M. (2018). "National Institutional ranking and Institutions of eminence.", *Current Science,* pp. 1031-1032.

Wang, K., & Mo, D. (2018, June). "The Suggestions on Accurate funding for Ethnic Minority Poor University Students.", *In 2018 International Conference on Sports, Arts, Education and Management Engineering (SAEME 2018),* pp. 633-639. Atlantis Press, doi: 10.2991/SAEME-18.2018.121

Watts, T. W. (2020). "Academic achievement and economic attainment: Re-examining associations between test scores and long-run earnings.", *Aera Open,* Vol. 6, No. 2, p. 2332858420928985.

Webster, D. (2022). "The ethical costs of using higher education for economic mobility.", *Theory and Research in Education,* Vol. 20, No. 3, pp. 237-258.

Weisskopf, T. E. (2004). "Impact of Reservation on Admissions to *Higher Education in India.", Economic and Political Weekly*, Vol.39, No.39, pp. 4339-4349 (11 pages).

Wicht, A., Müller, N., Haasler, S., & Nonnenmacher, A. (2019). "The interplay between education, skills, and job quality.", *Social Inclusion,* Vol. 7, No. 3. pp. 254-269.

Wint, N., (2023), "Why do students choose to study on engineering foundation year programmes within the UK?", *European Journal of Engineering Education,* Vol. *48, No.* 1, pp.157-179.

Yadav, S., (2022). "Women Education and Women Empowerment: Finding the Link for Societal Development.", *BSSS journal of social work,* Vol. 14, No. 1. pp.8-14.

Yadav,D., & Singh, S., (2020). "Status of Women Education in India", International Journal of Economics, Vol. 9, No. 1. pp. 28-35. doi: 10.34293/ECONOMICS.V9I1.3451

Yan, Y., & Gai, X. (2022). "High achievers from low family socioeconomic status families: Protective factors for academically resilient students." *International Journal of Environmental Research and Public Health*, Vol. 19, No. 23, p.15882.

Zhang, J., Jin, S., Li, T. and Wang, H. (2021), "Gender discrimination in China: Experimental evidence from the job market for college graduates", *Journal of comparative Economics,* Vol. 49, No.3, pp. 819-835.

Zou, X. (2023). "The Impact of Parents' Education Level and Occupation on Their Children's Educational Planning, Educational Resource Provision, and Family Education Practices." Lecture Notes in Education Psychology and Public Media, Vol. *13, No.*1, pp. 368-372. doi: 10.54254/2753-7048/2/2022286

## Appendix-1

**Share of Male and Female Participation (Management Wise) in Engineering Education in Delhi**

| | Male Participation | | Female Participation | | Total Students | | |
|---|---|---|---|---|---|---|---|
| | Govt. | Private | Govt | Private | Govt | Private | No. of Total Stu. |
| Caste | | | | | | | |
| General | 57.09 | 42.91 | 56.04 | 43.96 | 56.87 | 43.13 | 5852 |
| OBC | 92.76 | 7.24 | 91.18 | 8.82 | 92.49 | 7.51 | 1185 |
| SC | 55.66 | 44.34 | 62.91 | 37.09 | 57.06 | 42.94 | 1097 |
| ST | 85.04 | 14.96 | 93.75 | 6.25 | 87.26 | 12.74 | 314 |
| Religion | | | | | | | |
| Hindu | 63.97 | 36.03 | 64.66 | 35.34 | 64.11 | 35.89 | 7250 |
| Muslim | 94.52 | 5.48 | 96.47 | 3.53 | 94.85 | 5.15 | 505 |
| Sikh | 15.96 | 84.04 | 12.88 | 87.12 | 15.23 | 84.77 | 558 |
| Others* | 84.37 | 15.63 | 79.49 | 20.51 | 82.96 | 17.04 | 135 |
| Total | 63.12 | 36.88 | 62.64 | 37.36 | 63.02 | 36.98 | 8448 |

Source: Researcher's calculation from total number of students, Notes: Others*- Jain, Buddhist and Christian.

# Proof of Papers Published in Journals

# Analysing gender differences in academic performance and labour market outcomes of engineering graduates: evidence from India

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## Abstract

**Purpose** – Participation of women in engineering education is considerably low in India, although it is increasing in recent years. Also, engineering is primarily treated as a male-dominated profession, and the authors do not find many women in this sector. What factors contribute to this significant gender differences in engineering education and labour market in India? In this context, this study aims to examine the factors that explain the gender variations in academic performance and labour market outcomes (placement and earnings) of engineering graduates in India.

**Design/methodology/approach** – The paper is based on primary survey data from fourth-year engineering students in Delhi, collected in 2018–2019, with a total sample size of 3186. The study uses Ordinary least square method (OLS) and Heckman selection model to analyse gender differences in academic performance and labour market outcomes of engineering graduates, respectively.

**Findings** – The study finds that academic performance of male students is around 10.4% more than female students. However, this difference is heavily influenced by various socioeconomic and institutional factors. Interestingly, 3% of female engineering graduates have received more job offers than males, which contradicts the common belief that women engineers face job discrimination in the labour market in India. However, the authors find that male engineers earn around 7% more than female engineers shows the evidence of pro-male gender wage inequality in earnings. The findings support that there is a considerable variation in academic performance and earnings between male and female engineering graduates.

**Originality/value** – While the authors find some literature in the area of gender difference in the academic performance and labour market among university graduates in India, studies in the field of engineering education are sparse. In a context where fewer women are found in the field of engineering education along with low participation in the labour market, the findings of this study significantly contribute to the policy making.

**Keywords** Engineering education, Gender difference, Women participation, Academic performance, Labour market

**Paper type** Research paper

## 1. Introduction

Higher education which includes engineering and technical education is key to India's economic growth and development. It produces "specialised human capital" which contributes to dynamic economic growth, generating direct financial benefits and playing a similarly significant role in creating a huge number of social externalities. Determinately, it contributes to the national development in producing skilled human resources (Tilak and Choudhury, 2021). Further, with the considerable contributions of women to Indian economy and society, improving their participation in higher and technical education is focused in the policy space. Women's participation in University education is not only an important aspect in development of the country; it is a crucial element in the process of improving the quality of life of women themselves because it has a direct effect on women's productivity and earnings as well (Morley, 2006).

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# How do Students from Socially Backward Caste Groups Perform in Engineering Education? Evidence from India

Itishree Choudhury and Seema Singh*

*Literature available on the academic performance of students in higher education is sparse, particularly in India. Limited research exists that precisely examines the academic performance of engineering students and the factors that contribute to their success. Utilising primary survey data of 2288 fourth-year engineering students in Delhi, this paper specifically examines how the academic performance (Measured by Cumulative Grade Point Average) of students from socially disadvantaged caste groups (SC/ST and OBC) varies in India and what factors determine this. In this context, the study revealed a considerable performance gap among engineering students of different social groups. Especially, the findings indicate a significant gender and caste disparity in academic performance in engineering education. Females exhibited about 16.5 per cent lower performance compared to males, and SC/ST students demonstrated around 38 per cent lower performance in comparison to their OBC counterparts. We find that various aspects of the socio-economic background and factors related to the educational environment such as the type of institution, scholarships, and past academic experiences, are significantly determining the academic performance of engineering graduates from socially backward caste groups. Given the poor linkage between engineering education and the labour market, the findings of the study have considerable policy implications.*

**Keywords:** *Engineering, Socially backward students, Academic performance, Delhi*

## I. INTRODUCTION

Education as a key factor for the empowerment and advancement of any community has been widely recognized, and higher education is increasingly viewed as an investment in human resources in all countries (Psacharopoulos & Patrinos,2018; UNESCO,2019). It is universally accepted that the development of education among the general population is crucial for the overall progress of Indian society. Especially, education is an important tool for the empowerment and development of socially and economically disadvantaged groups such as Scheduled Castes (SC), Scheduled Tribes (ST), and Other Backward Classes (OBC). The need of education not only acts as a

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# ENGINEERING EDUCATION AND LABOUR MARKET IN DELHI: ISSUES AND CHALENGES

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***ABSTRACT***

*The human capital framework provides a theoretical explanation for investing in education and skills of individuals in order to prepare them to take advantage of the positive labor market outcomes. It can be developed by means of education/schooling, adequate training and development of skills which have a positive impact on output and earnings. The paper aims to examining the trend and pattern of the expansion of engineering education in Delhi and to analyse the employment probabilities and associated earnings of engineering graduates.In order to examine and estimate the above statement, this study is going to use secondary time series data on growth of engineering institutions and student enrollment, in Delhi, with some reviewing research works. The finding of these reviewed papers suggests that there is no such balance growth between enrollment engineering student and employment. The probability of getting employment is higher for the graduates of government engineering as compare to private institutions. Also, the expected earnings of the graduates of private institutions is less than that of the graduates of government institutions.*

*Keywords: Engineering Education; Labor Market; Employment Probabilities; Expected Earnings; Literature review, Delhi.*

## INTRODUCTION

The human capital theory strongly advocates for investment in higher and technical education that makes a vital contribution to accelerate the process and the rate of economic growth through enhancing human skill and productivity. Further the emergence of "knowledge economy "has duly focused on the linkages between higher education, knowledge and wealth creation, which is essential in the present competitive global scenario for a nation to grow. This is policy by strengthening a country's engineering and technical education, such as in the case of a developing country like India. An important educational police document (National Policy on Education, Government of India 1986) of the nation has clearly emphasized the fact by stating. Technical education is one of the most significant components of human resources development spectrum with great potential for adding value products and services and for contributing to the national economy and improving quality of life of the people. The important laid to has put pressure for the greater demand of graduate in the engineering and technical education. However, within six decades of expansion of engineering and technical education in post-independence of India, a number of issues like uneven growth, low quality, low social coverage, educated unemployment and under employment, lack of academic interaction between industry and engineering institutions has come up in a serious way and demands for a detail discussion on these issues. Under this backdrop the present paper attempts to analyze the existing relationship between engineering education and labor market, Delhi in India. The paper evidences that there is a massive quantitative expansion of engineering education in India also the state of Delhi, over the years but with a mismatch between demand and supply. There is a huge crisis of qualified faculty in this discipline which hampers the quality of education and hence the problem of unemployment and under employment in the labor market.

However, there is attempt to analyze and discuss the growth of engineering education in terms of institutional expansion and enrolment capacity. This analysis is essential in order to get an overall picture of this discipline in Delhi. And also this paper has analyzed the changing pattern in the growth of engineering education in Delhi. Using the secondary data from the publications of the Ministry of Human Resource Development (MHRD), University Grants Commission (Higher Education in India at a Glance, Annual Reports); All India Council for Technical Education (AICTE), this paper has analyzed the changing pattern in the growth

**ANNEXURE-IV**

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# Bio-data

Itishree Choudhury is a research scholar in economics under the supervision of Prof. Seema Singh at the Department of Humanities since July 2017, Delhi Technological University (DTU), Delhi, India. Before coming to DTU she did her M.Phil (Economics) degree from Dr B.R. Ambedkar University, Indore, India. She received a Master's degree in Economics from North Odisha University, Odisha, India. She has three publications in journals related to her Ph.D research area, listed by Emerald Publisher and included in the UGC CARE list. She presented three papers for the international conferences. Her research interests are Gender, Labour market, Informal Worker, Affirmative action in technical higher education. She can be contacted at: shreeeconomics17@gmail.com.