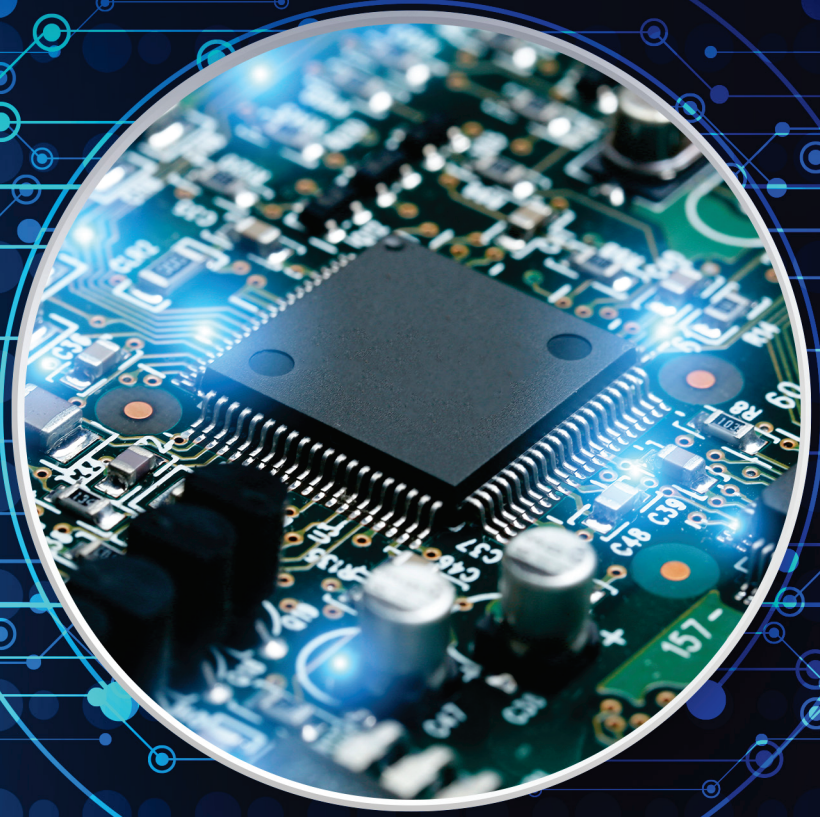
ESSCI
Skilling India in Electronics

Skill India
कौशल भारत-कुशल भारत

A STUDY TO

# IDENTIFY THE SKILL REQUIREMENT & ASSESS THE JOB POTENTIAL IN INDIAN ELECTRONICS INDUSTRY



- Semiconductor & Components
- Electronics Manufacturing Services (EMS)
- Hearables & Wearables
- Circularity / E-waste management

KANTAR

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# Content

CHAPTERS

# Foreword

The Indian Electronics market has witnessed an unprecedented growth and the Electronics manufacturing having achieved 80 Billion USD in 2021-22, supported by Government of India incentivising Electronics Manufacturing through schemes like the PLI, SPECS and EMSC.2

The growth in the market has resulted in increase in demand for trained and skilled manpower in the electronics sector. The Electronics Sector Skills Council of India-ESSCI anticipated this demand and accordingly aligned itself to meet the challenge and expand capacity.

ESSCI is a not-for-profit company headquartered in New Delhi. It was formed by the six major electronics industry associations representing the ESDM sector – ELCINA, MAIT, IESA, IPCA, CEAMA and ELCOMA.

The Electronics Sector Skills Council of India (ESSCI) has periodically undertaken research to identify skill gap & number of estimated job analysis in the Electronics System Design and Manufacturing-ESDM domain in order to map current and future skill requirement across different application sectors, and, to identify skill gaps to assess the focus areas.

The rise in the electronics market also let to some Sub-Sectors witnessing a higher rate of growth and emergence of new areas was witnessed.

ESSCI appointed Kantar to conduct research to identify the skill requirement & access the job potential in Indian Electronics industry sectors for the next three years in these emerging areas.

**KANTAR** is the world's leading marketing data and analytics company with deep understanding of the global markets and having their presence in over 90 countries,

Four emergent sub-sectors which were covered during the study instituted in 2022, included the following:

(1) Semiconductors & Components:
(2) Electronics Manufacturing Services (EMS)
(3) Hearables & Wearables
(4) Circularity/ E-waste management.

The reports seek to bring the desired clarity for the industry and the ESSCI to develop a far reaching implementable action plan to ensure required capacity, mechanism, qualifications and partnerships are forged to ensure enough capacity to meet demand for highly skilled manpower.

***Dr. Abhilasha Gaur***
*COO, Electronics Sector Skills Council of India (ESSCI)*

# Executive summary

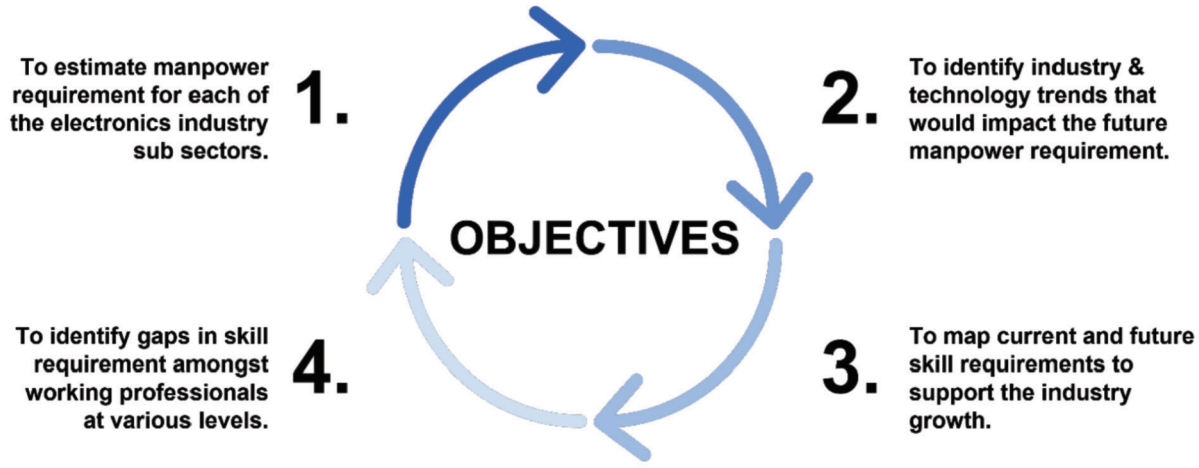
## Study background

Electronics Sector Skills Council of India (ESSCI) has periodically undertaken research to identify skill gaps & number of estimated job analysis for next 5 years in Electronic Design and Manufacturing domain in order to map current and future skill requirements across different application sectors, and, to identify skill gaps to assess the focus areas. ESSCI appointed Kantar to conduct research for the assessment period 2021-22.

Four sub-sectors which were covered during the study include:

| | |
|---|---|
| 1. | **Semiconductors & components** |
| 2. | **Electronics manufacturing services (EMS)** |
| 3. | **Hearables & wearables** |
| 4. | **Circularity/E-waste management** |

The objectives of this research were:




A mix of desk/secondary research and primary research (both qualitative and quantitative) was conducted during the study. A total of 28 qualitative interviews and 180 quantitative interviews across various segments such as organizations (senior HR or management personnel as well as employees), training institutes and policy makers were covered during the course of the study.

This document is the final report of the study comprising of findings from desk/secondary research as well as primary research (both qualitative and quantitative phases).

## Research findings in a snapshot

Table below gives the market size, in US$ billion, in 2021-22 and its projections till 2025-26 for sub-sectors such as semiconductors and components, electronics manufacturing services and hearables & wearables. It also gives total e-waste generated, and its projections, in million metric tonnes (MMT).

*Figure 1: Market scenario - India for various sub-sectors of electronics industry (summary)*

| Sub-sector | 2021-22 | 2022-23 (E) | 2023-24 (E) | 2024-25 (E) | 2025-26 (E) |
|---|---|---|---|---|---|
| **Semiconductor & components** *Market size in US$ billion* | 82.0 | 95.0 | 110.0 | 128.0 | 148.0 |
| **Electronics manufacturing services (EMS)** *Market size in US$ billion* | 49.0 | 72.0 | 104.0 | 151.0 | 218.0 |
| **Hearables & wearables** *Market size in US$ billion* | 1.0 | 1.5 | 2.3 | 3.6 | 5.5 |
| **E-waste management** *Generation in MMT* | 6.2 | 7.7 | 9.5 | 11.5 | 14.2 |

Table below gives manpower employed in these four sub-sectors currently, i.e., in 2021-22, and its projections till 2025-26.

*Figure 2: Manpower scenario - India for various sub-sectors of electronics industry (summary)*

| Sub-sector | 2021-22 | 2022-23 (E) | 2023-24 (E) | 2024-25 (E) | 2025-26 (E) |
|---|---|---|---|---|---|
| **Semiconductor & components** *Manpower in '000* | 139 | 167 | 200 | 240 | 288 |
| **Electronics manufacturing services (EMS)** *Manpower in '000* | 1,200 | 1,800 | 2,700 | 4,100 | 6,200 |
| **Hearables & wearables** *Manpower in '000* | 10 | 15 | 23 | 34 | 50 |
| **E-waste management** *Manpower in '000* | 1,160 | 1,250 | 1,350 | 1,450 | 1,560 |

The highest number of manpower is currently employed in electronics manufacturing services and e-waste management sectors. The manpower employed in EMS sector is not only a skilled workforce it also has the highest growth potential in future.

## Electronics industry in India

Electronics market in India is estimated to be around US$ 340 billion in the year 2021-22. Of this market, less than 50% is contributed to by domestic production while a bulk is catered to by imports. Indian domestic electronics manufacturing sector faces multiple disabilities which does not allow it a level playing field and makes it uncompetitive with respect to competing nations. These disabilities include insufficient infrastructure, issues with domestic supply chain and logistics, inadequate access to quality

power/energy, low manufacturing base for electronic components, high cost of finance, limited design & R&D focus as well as inadequate skillset. The primary push towards the growth of electronics sector in India would come from policy push which aims to make India a manufacturing hub for electronics. Growth in electronics sector in India will not only contribute to foreign exchange earnings through exports but would also provide a spur to employment generation in the country. However, in order to truly make India a global electronics manufacturing hub, a skilled workforce is of utmost priority.

## Semiconductors & components

Indian semiconductor industry is dominated by the fabless (or design) phase of the value chain with almost negligible fabrication and OSAT/ATMP operations. Semi-conductor and components market in India is estimated to be around US$ 82 billion in the year 2021-22. It has been growing, almost consistently, at a CAGR of around 15% since 2015. Growing at the same pace, it is likely to cross US$ 150 billion in the next 5 years. The Indian semiconductor design market is dominated by embedded systems design with as much as 85-90% share of the revenue. There are three key factors which would drive the growth of semi-conductors and components sector in India, viz. government support, focus on ATMP and bullish industry plans.

Semiconductors and components sub-sector is estimated to employ around 1.39 Lacs personnel in the year 2021-22. This is up from 1.05 Lacs personnel in the year 2018-19 and has been growing at a rate of around 10% (CAGR). As per Kantar analysis, a realistic scenario would be a growth rate of around 18-22% in the manpower requirement for next 4-5 years. it is expected that by the year 2025-26, semi-conductor and components sector would employ close to 3 Lacs people in various roles. A bulk of manpower, around 55%, is employed in design and research & development roles as well as those in managerial roles such as business development and marketing. Around 30% of the manpower is in manufacturing, assembly & testing roles and 15% in quality assurance/control roles as well as other service roles such as after-sales services. However, as the manufacturing component of the industry gains traction – driven by factors highlighted above – the share of manufacturing roles in the manpower pool will grow and is expected to reach around 35-40% by 2025-26 from current 30%.

Top job roles in the semiconductors and components sector include Quality Analysis & Reliability Engineer, Wafer Test & Sort Engineer, Very Large-Scale Integration (VLSI) Design Engineer, Package Design Engineer, Embedded Product Design Engineer – Technical Lead and Embedded Software Engineer. Most of these jobs require a minimum graduate degree (technical) and with a postgraduate (technical) qualification preferred by the companies. Industry experience is preferred. For most of these job roles, technical knowledge of computer hardware and software systems, technical knowledge of electronics and electrical systems, knowledge of circuit design, knowledge of information technology & information systems and knowledge of testing are considered critical. Top soft skills include problem identification & solving, project management and/or production management, leadership and team management, communication skills & product development and management.

## Electronics Manufacturing Services (EMS)

Electronics Manufacturing Services (EMS) market in India was estimated to be around US$ 49 billion in 2021-22. Close to half of the EMS industry in India caters to mobile phones, followed by television, computer hardware as well as telecom and networking equipment which, all together, comprise of around 60% of the EMS industry in India. Indian EMS industry is expected to grow at a CAGR of around 45%. As per these estimates, it is expected to cross US$ 215 billion by 2025-26. Key drivers for this growth would be China+1 strategy of major electronics OEMs and EMS MNCs, OEM to ODM movement, rising consumer demand and favourable government policies.

EMS sector in India employs around 12 Lacs people currently. A bulk of manpower, around 50%, is employed in manufacturing, assembly & testing roles and the rest in design, R&D, quality assurance/control roles as well as other service roles such as after-sales services. During the period 2016 to 2022, this employee base has grown at a rapid rate (CAGR) of more than 50%. It is expected that the manpower would continue growing at the same rate – i.e., around 50% - at least for next 4-5 years. Therefore, it is estimated that this sector would employ more than 6 million people by the end of 2025-26.

Top job roles in electronics manufacturing services (EMS) include Incoming Materials Inspector – Electronic Items, Assembly Operator, EMS Operation & Maintenance Manager, EMS Technician, Assembly Line Operator. While EMS Technician has a minimum education requirement of Diploma/ITI, all other job roles require a Graduation (Technical) with an Assembly Line Operator being able to apply for the job even with a non-technical graduation. These jobs also require the individual to have industry experience except for EMS technician who does not require any industry experience to apply. Key technical skills required for personnel in these job roles include knowledge of computer hardware/ software, technical knowledge (electronics / electrical), circuit design, quality control / assurance, systems analysis and testing while major non-technical skills include communication skills, project or production management, leadership / team management and problem identification & solving skills etc.

## Wearables & hearables

The current market size for this segment is low and is just around US$ 1 billion. As much as 90% of this market is comprised of the hearables sub-segment. Over the last couple of years, manufacturing in India has seen a robust growth. In fact, specifically in the smart watch category, India's share in global shipments has risen sharply in 2021 from 2020. The Government of India Vision document aims to manufacture US$ 8 billion worth of wearables & hearables in India by 2025-26. Out of this, around US$ 2.5 billion would be slated for exports while the rest would cater to the Indian market. Therefore, there is a huge potential for an accelerated growth in this sector. The key driver for this growth includes increase in usage of hearing devices due to work-from-home culture driven by Covid-19 as well as increase in utilization of the over-the-top (OTT) platforms.

The current manpower employed in this sector is quite low and is estimated to be less than 10,000 personnel employed in various roles – both on permanent and contract basis. Sales and marketing is the major function. However, as the sector grows rapidly and the production expands, this manpower requirement can be expected to increase multi-fold and with a greater proportion, than current, staff in production roles. A conservative estimate of manpower requirement for this sector in 2025-26 would be around 50,000 which is 5 times the manpower currently employed by this sector.

A large part of the work force, both permanent and contractual, belong to sales/marketing and after-sales services. Top technical skills, therefore, required for personnel in this industry include quality control/assurance, basic knowledge of computer hardware/software, technical knowledge (electronics/ electrical) and data analytics while soft skills include communication skills, project or production management, leadership / team management and problem identification & solving skills.

## Circularity/E-waste management

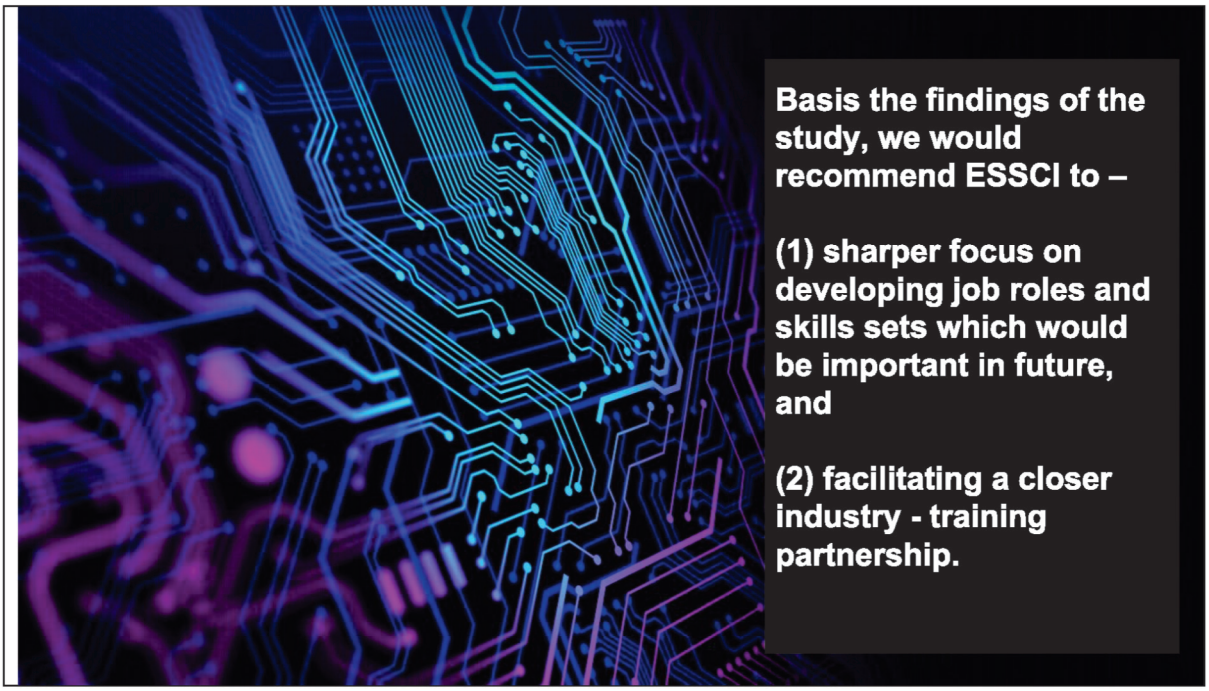
E-waste management is a huge sector with a value chain spanning from collection (which involves a huge number of garbage collectors in unorganized domain as well as organized collection efforts of electronic products OEMs), aggregation, segregation, dismantling and recycling. A vast proportion – even upwards of 90% - of the manpower employed in e-waste management sector is in unorganized sector, but it is estimated that more than 10 Lacs people in India are involved in manual recycling operations as of June 2020. The total manpower employed at the last mile – i.e., with dismantlers & recyclers – could be in the range of 10-15,000. A further 4.5 Lacs of direct jobs is estimated to be created by 2025.

Revenue is generated for relevant stakeholders at each stage of this value chain. However, due to highly unorganized nature of this industry, there is no estimate, so far, regarding the total value of e-waste management 'market' in India. The only clear estimate is that of total e-waste generation in the country – which is estimated to be around 3.2 million metric tonnes (MMT) in 2019. This considers into account all 21 types of electrical and electronic equipment listed in E-Waste Management Rules, 2016. It is estimated that by the year 2025, total e-waste generation is likely to reach around 11.5 MMT.

Top job roles in e-waste management sector include that of collection executives, marketing/business development, operations and/or production, sales/after-sales. Top skills include knowledge of recycling technology, understanding of quality norms & standards at various steps of dismantling & recycling, operation of machines used in dismantling & recycling, SPC review, DRB completion, audit support,

supplier quality management, complaint investigation are some technical skills relevant in this sub-sector.

## In conclusion




These recommendations are explained in the final chapter of the report.

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# Study background

## Background of the study

Indian Electronics Manufacturing Industry is all set to quadruple to US$ 300 Billion by 2026[1]. This would open up opportunities in terms manufacturing units' expansion and at the same time be the attraction for global manufacturers to set up units here. In such scenario, it is evident that there will be huge focus on manpower so as to be better prepared for the expansion. Since the electronics manufacturing industry has high dependence on skilled manpower, especially for highly specialized activities such as electronics system design, IC design and manufacturing etc., the availability of talent with relevant skill sets assumes considerable importance. Furthermore, adoption of emerging technologies is also leading to emergence of new age jobs and connected job roles that need to be assessed.

Hence, it is crucial to review skill requirements in this electronics industry to understand the different requirement across functional roles starting from factory level to R&D level so that India can build the required skill base.

Electronics Sector Skills Council of India (ESSCI) has periodically undertaken research to identify skill gap & number of estimated job analysis for next 5 years in Electronic Design and Manufacturing domain in order to map current and future skill requirement across different application sectors, and, to identify of skill gaps to assess the focus areas.

ESSCI appointed Kantar to conduct research for the assessment period 2021-22. This document is the final report of the study comprising of findings from desk/secondary research as well as primary research (both qualitative and quantitative phases).

## Objectives and scope

The objectives of this research were:

1. To estimate manpower requirement for each of the electronics industry sub sectors.
2. To identify industry & technology trends that would impact the future manpower requirement.
3. To map current and future skill requirements to support the industry growth.
4. To identify gaps in skill requirement amongst working professionals at various levels.

Four sub-sectors which form the scope of the study are as follows:

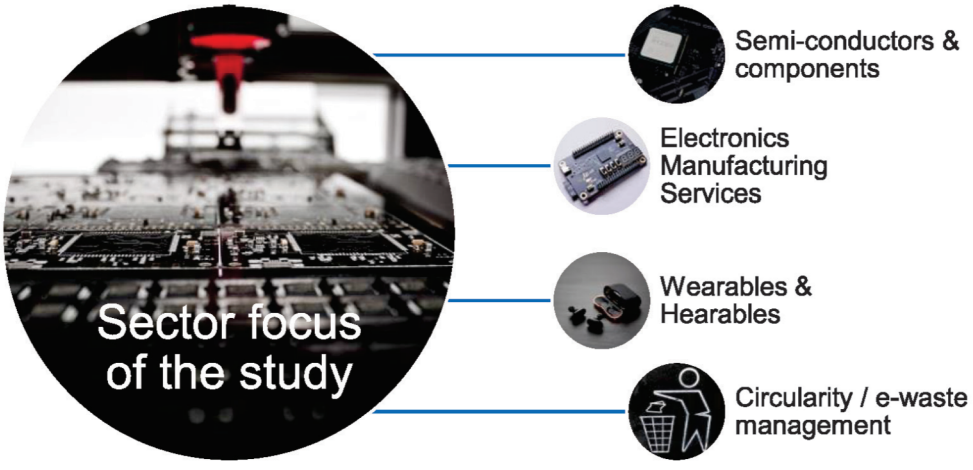
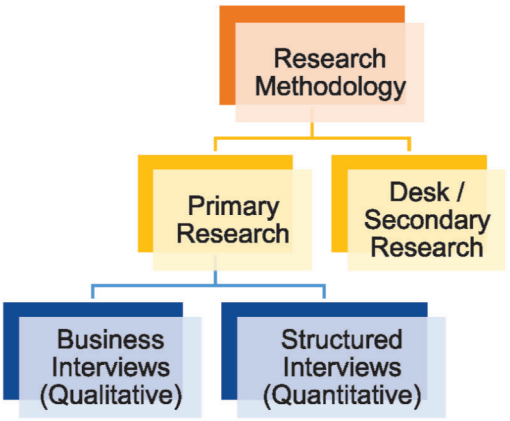



*Figure 3: Sub-sector focus of the study*

1 Source: Vision Document, Govt. Of India

# Research methodology

A mix of desk/secondary research and primary research (both qualitative and quantitative) was conducted during the study.




**Qualitative primary research:** Unstructured Business Interviews (UBIs) were used to conduct qualitative primary research. These discussions are conducted in a free-flowing manner that allows the discussion to capture both the qualitative responses and the quantitative numbers associated. The objective of these interviews was to gather the perspective of employees and employers of the companies and training institutes operating in focus sectors. These interviews were mostly conducted telephonically and lasted between 30 to 60 minutes.

**Quantitative primary research:** Structured questionnaire, using CAWI (computer-aided web interviews or online interviews) method, were conducted with stakeholders such as employees and employers of the companies and training institutes operating in focus sectors. Typical length of the interview was around 25-30 minutes.

**Desk/secondary research:** Various sources of information such as previous ESSCI reports, published survey results, reports by industry associations such as IESA (Indian Electronics & Semiconductor Association), etc.

# Target segments & sample size

Table below showcases target respondent segments and the respondent profile covered in those segments as well as planned and achieved sample in both qualitative and quantitative phases.

*Figure 4: Target respondent segments and sample size*

| Segment | Respondent profile | Sample Size | | | |
|---|---|---|---|---|---|
| | | Qualitative | | Quantitative | |
| | | Planned | Achieved | Planned | Achieved |
| Employers | Either business / functional heads of selected job levels / functions or mid to senior level HR professionals. | 10 to 12 | 12 | 30 | 30 |
| Employees | Senior and mid-level executives from selected functions / departments, across different sub sectors. | 10 to 12 | 10 | 120 | 120 |
| Training institutes | Trainers in vocational training institutes. | 1 to 2 | 3 | 30 | 30 |
| Policy makers | Key personnel from MeitY, NSDC, etc. | 2 to 3 | 3 | --- | --- |
| **Total sample size** | | **~ 26** | **28** | **180** | **180** |

# Electronics industry in India

Electronic products are ubiquitous in today's world and find applications across various industry segments such as information technology, automotive, tele-communication, consumer durables & electronics, industrial electronics, aviation, defence, medical technology, agri-tech etc. Electronics industry is one of the largest and fastest growing sectors globally. Its importance towards contributing to a robust growth of Indian economy has been attested to in the Government of India's National Policy on Electronics 2019[2].

Electronics market comprises of electronics products (domestic consumption + exports), electronics components, electronics design and electronics manufacturing services (EMS)[3].

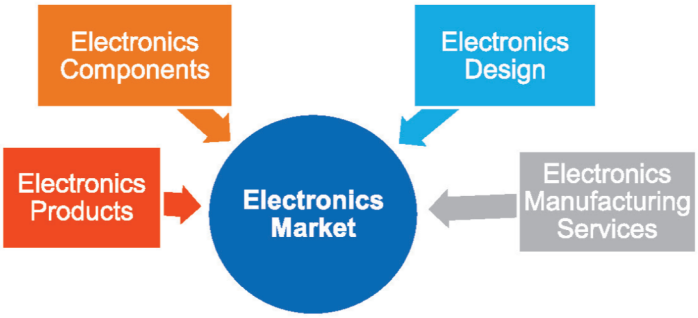



*Figure 5: Constituents of electronics market in India*

ESDM, or Electronics System Design & Manufacturing, is a subset of electronics market and includes electronics systems, i.e., the value of electronic parts in a product and electronics design market[4].

Electronics market in India is estimated to be around US$ 340 billion in the year 2021-22[5]. Of this market, less than 50% is contributed to by domestic production while a bulk is catered to by imports[6].

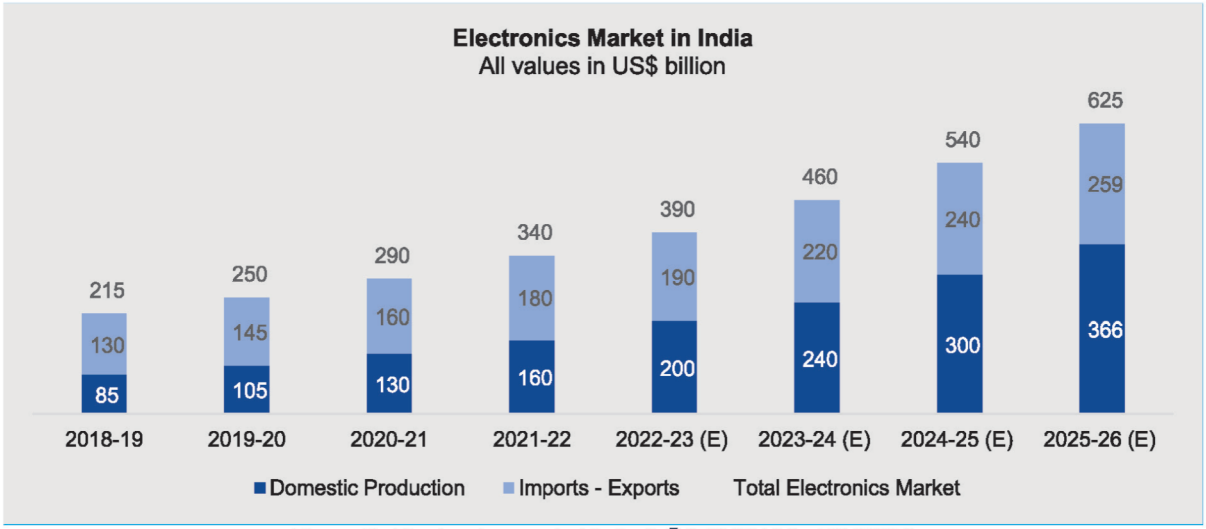



*Figure 6: Electronics market in India[7] (FY 2018 to FY 2025)*

*2 https://www.meity.gov.in/writereaddata/files/Notification_NPE2019_dated25.02.2019.pdf*
*3 https://www.ibef.org/industry/electronics-system-design-manufacturing-esdm, https://niveshmitra.up.nic.in/ElectronicSector.aspx,*
*4 https://iesaonline.org/images/Research/Exec-Summary-IESA-ESDM-report-Mar-2020.pdf*
*5 https://iesaonline.org/images/Research/Exec-Summary-IESA-ESDM-report-Mar-2020.pdf*
*6 https://iesaonline.org/images/Research/Exec-Summary-IESA-ESDM-report-Mar-2020.pdf*
*7 https://iesaonline.org/images/Research/Exec-Summary-IESA-ESDM-report-Mar-2020.pdf, Kantar analysis.*

Indian domestic electronics manufacturing sector faces multiple disabilities which does not allow it a level playing field and makes it uncompetitive with respect to competing nations. These disabilities include insufficient infrastructure, issues with domestic supply chain and logistics, inadequate access to quality power/energy, low manufacturing base for electronic components, high cost of finance, limited design & R&D focus as well as inadequate skillset[8].

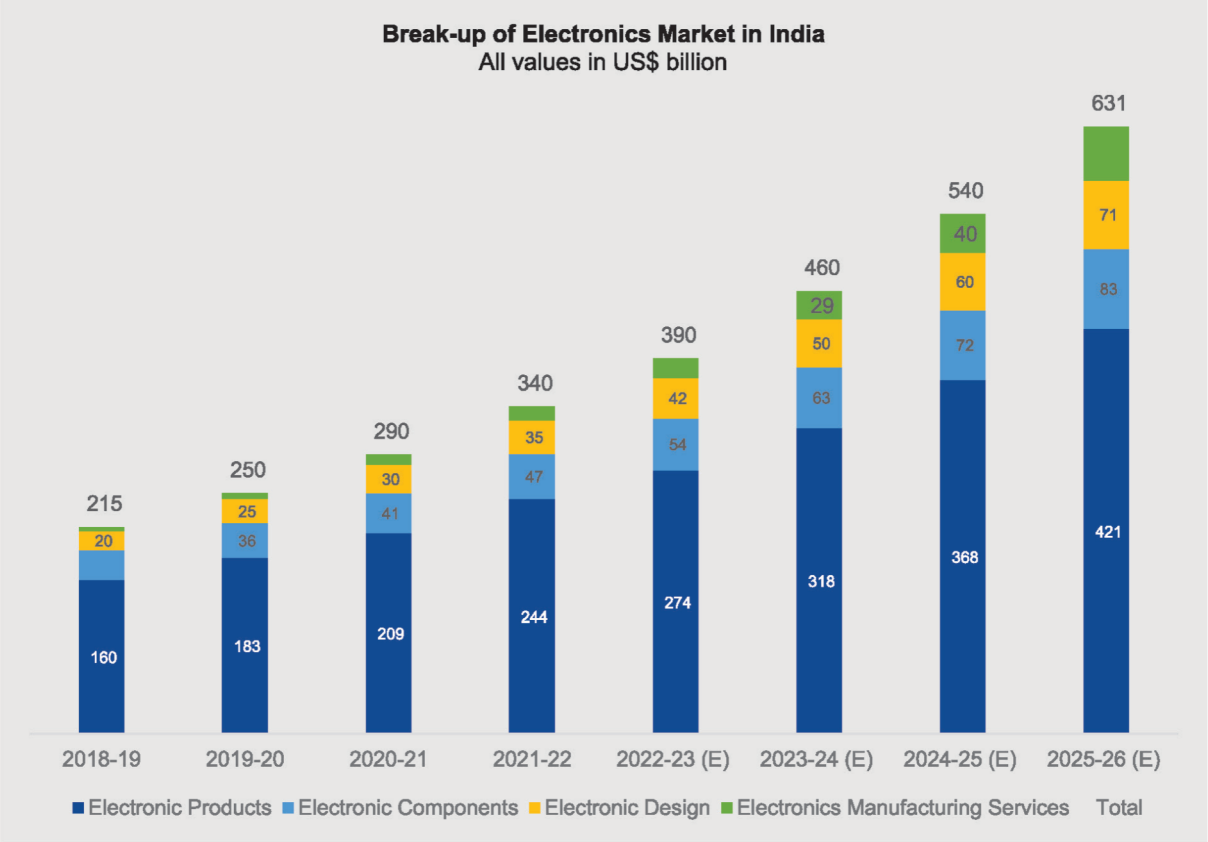



*Figure 7: Break-up of electronics market in India[9] (FY 2018 to FY 2025)*

The primary push towards the growth of electronics sector in India would come from policy push which aims to make India a manufacturing hub for electronics. The National Policy for Electronics 2019 was launched by Government of India to make India a global hub for Electronics System Design and Manufacturing (ESDM). In fact, ESDM has been included among the 25 priority sectors in the Make in India initiative. Apart from the policy push, various other factors such as increasing labour costs in China, Covid-19 outbreak, geopolitical trade and security environment are driving many electronic majors to look for alternate manufacturing destinations and India is emerging to be a leading option. In fact, electronics sector has the potential to become one of the top exporters in India over the next few years.

**Not only would growth in electronics sector in India contribute to foreign exchange earnings through exports but would also provide a spur to employment generation in the country. However, in order to truly make India a global electronics manufacturing hub, a skilled workforce is of utmost priority. This report assesses the current manpower available in the sector as well as its projection into the future along with the skills required among these personnel.**

*8 https://www.meity.gov.in/writereaddata/files/Notification_NPE2019_dated25.02.2019.pdf*
*9 https://iesaonline.org/images/Research/Exec-Summary-IESA-ESDM-report-Mar-2020.pdf, Kantar analysis*

# Semi-conductor & components

## Introduction

Semiconductors are materials with intermediate conducting capabilities, i.e., that between a conductor and an insulator, which after doping (i.e., adding impurities) can be used to manufacture semiconductor devices. Semiconductor materials, especially silicon, are also the base material for monolithic integrated circuits (simply known as ICs or microchips) which are used in almost all modern electronic devices. In fact, semiconductors can be considered to be brains[10] of modern electronics, and are the unsung heroes[11] of the technology world and have been the key reason behind advances in other industries such as communications, computing, healthcare, transportation, energy, consumer electronics, lighting, etc. Two most common types of ICs are the logic chips and the memory chips. While the former processes information and allows electronic devices to 'complete their tasks', the latter stores information.

The semiconductor industry comprises of companies which are involved in design (also called fabless phase), fabrication (also called foundry phase or fab phase) and assembly, testing & packaging (further divided into two phases – OSAT, i.e., outsourced semiconductor assembly & testing, and ATMP, i.e., assembly, testing, marking & packaging) of semiconductors and semiconductor devices.

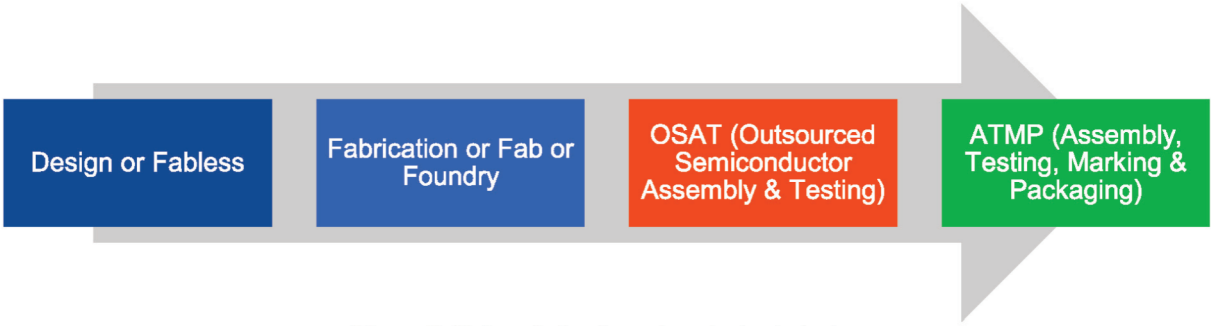



*Figure 8: Value chain of semiconductor industry*

**Design or fabless:** These are companies which conduct research & development in semiconductors as well as design semiconductor devices. These companies do not manufacture or fabricate these integrated circuits themselves but outsource them to fab or foundry players. Top fabless companies globally include[12] Qualcomm, Nvidia, Broadcom, AMD etc.

**Fab or foundry:** These are semiconductor manufacturers that make chips for other companies i.e., the design or fabless companies. This is a highly specialized phase of the semiconductor manufacturing process which requires dedicated facilities which are highly capital intensive to set-up. In fact, major technology majors such as Qualcomm, Apple, Nvidia etc. also outsource their chip manufacturing to fab players. Top players in this segment include TSMC (Taiwan Semiconductor Manufacturing Company), Samsung, UMC, Global Foundries, SMIC (Semiconductor Manufacturing International Corporation), etc.

**OSAT/ATMPs[13]:** OSAT (Outsourced Semiconductor Assembly & Testing) companies convert the bare wafer silicon into a packaged product before shipping them to ATMPs. OSAT process ensures defect free and durable semiconductor products. ATMPs (Assembly, Testing, Marking & Packaging) assembly the packaged semiconductor devices received from OSATs onto a printed circuit board (PCB) before final packaging.

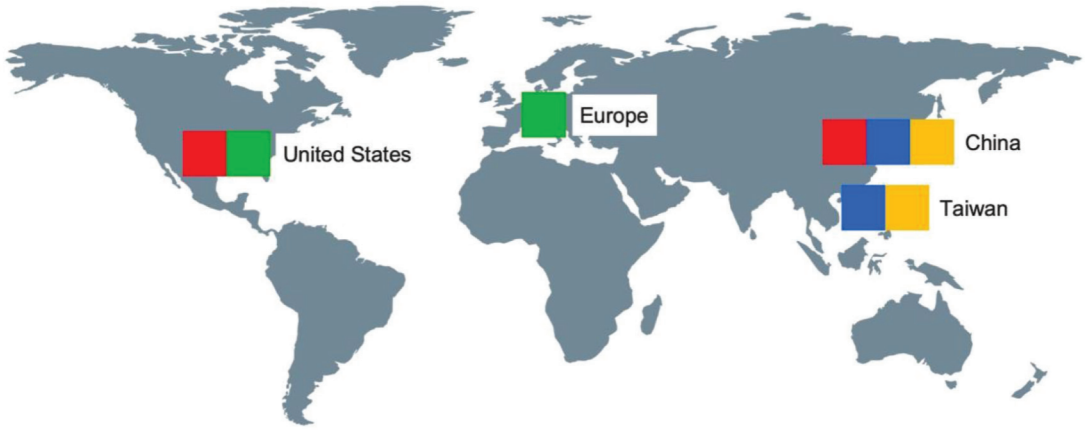
[10] *https://www.semiconductors.org/semiconductors-101/what-is-a-semiconductor/*
[11] *https://www.mckinsey.com/industries/advanced-electronics/our-insights/semiconductor-design-and-manufacturing-achieving-leading-edge-capabilities*
[12] *https://www.extremetech.com/computing/337153-trendforce-ranks-the-top-ten-fabless-semiconductor-companies*
[13] *https://www.chetanpatil.in/the-importance-of-end-to-end-semiconductor-cluster-ecosystem/*

Semiconductor components are, generally, divided into three types[14]:

1. **Active components[15]:** These are electronic components that can amplify an electrical signal or produce power gain. Some common active components include integrated circuits, diode, transistors etc.
2. **Passive components[16]:** These components consume energy and do not have the ability to provide a power gain. However, they may impact voltage or current. Some examples of passive components are resistors, capacitors, inductors, transformers etc.
3. **Electro-mechanical components:** These are components which use an electrical signal to cause a mechanical function. For e.g., turning of a motor. Some examples include connectors, fuse, switches, speakers, cables, relays etc.
4. **Other components:** These include wound components (e.g., coils, rectifiers etc.), bare PCBs, PCB assemblies, etc.

## Semiconductor & components: Global scenario

Semiconductor industry is based on the 'foundry model[17]' where each of the above phases of the value chain belong to separate companies (or at least subsidiaries). There are, however, some companies – called as integrated device manufacturers (IDMs) – who both design as well as manufacture semiconductors. In fact, this has meant that no region of the world has end-to-end capabilities for semiconductor design and manufacturing (see figure below).




Note: Share of sales of semi-conductor companies (2018) based on headquarter locations


*Figure 9: Global spread of semi-conductor industry[18]*

[14] *https://www.eletimes.com/what-are-electronic-components-types-classification-and-major-applications-of-electronic-components*
[15] *https://www.techopedia.com/definition/726/active-component*
[16] *https://www.techopedia.com/definition/735/passive-component, https://www.eletimes.com/what-are-electronic-components-types-classification-and-major-applications-of-electronic-components*
[17] *https://en.wikipedia.org/wiki/Semiconductor_industry#Industry_structure*
[18] *https://www.mckinsey.com/industries/advanced-electronics/our-insights/semiconductor-design-and-manufacturing-achieving-leading-edge-capabilities*

The value chain has high level of interdependencies between countries/regions, high level of division of labour (since different phases of value chain have different level of capital and labour requirement) and requires close collaboration between companies.

The global semiconductor and components industry is estimated to be more than US$ 900 billion (sales) in 2022-23 and has been growing at a rate of 7% during the last 5-7 years. Components have, generally, formed around one-third of the total sales in semiconductors and components industry. The semiconductor and components industry itself has been around 20-25% of the total electronics industry globally (the rest being AV equipment, communications, computer & information terminals, display devices, other electronic equipment and services).

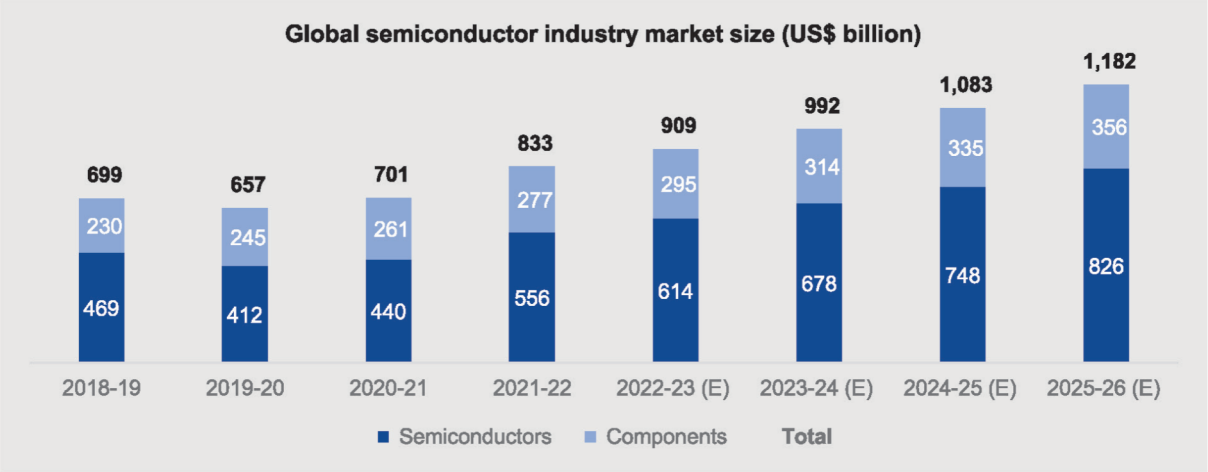



*Figure 10: Global semiconductor and components industry market size[19] (FY 2018 to FY 2025)*

The global semiconductors and components industry is likely to keep growing at around 8-12% CAGR for the next few years. This will be driven not only by rise in demand for consumer electronics and information technology products but also due to demand in computing power for emerging technologies such as artificial intelligence (AI) and machine learning (ML) as well as Internet of Things (IoT).

## Defining the sub-sector

For the purpose of the study, semi-conductors & components is defined as comprised of two key parts:

1. **Semi-conductors:** While fabrication/manufacturing of semi-conductors in India is generally absent, the design part (i.e., the fabless component) is quite strong with many MNCs having their design units in India. For the purpose of estimation, semi-conductors would be, therefore, considered as the 'design' part of ESDM in India.

2. **Components:** Components manufacturing in India comprise of active and passive components, electro-mechanical components etc.[20].


*Figure 11: Defining semi-conductors and components sub-sector.*

[19] https://www.statista.com/statistics/266973/global-semiconductor-sales-since-1988/, ELCINA, Kantar analysis.
20 https://iesaonline.org/images/Research/Executive-summary-2017-Indian-ESDM-Industry-Update.pdf

## Semiconductor & components: Indian scenario

Indian semiconductor industry is dominated by the fabless (or design) phase of the value chain with almost negligible fabrication and OSAT/ATMP operations. Most major global semi-conductor companies have their design centres in India. In addition, there are also many Indian fabless start-ups which have come up recently. The key driver for India developing as a global design / fabless destination is availability of cheaper talent and other cost factors.

Semi-conductor and components market in India is estimated to be around US$ 82 billion in the year 2021-22. It has been growing, almost consistently, at a CAGR of around 15% since 2015. Growing at the same pace, it is likely to cross US$ 150 billion in the next 5 years.

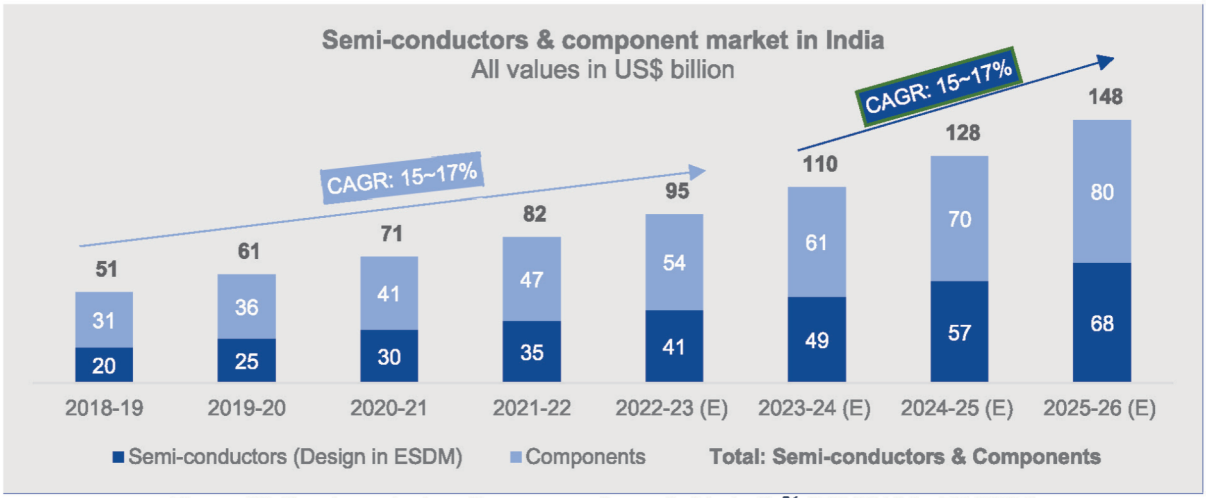



*Figure 12: Semi-conductors & components market in India[21] (FY 2018 to FY 2025)*

Future expected growth rate of various sub-segments of the semiconductor and components industry are as follows:

| Fabless, design and/or R&D | Foundry, manufacturing and/or fabrication | Assembly, testing and/or OSAT/ATMP | Services such as business development, after-sales etc. |
|---|---|---|---|
| 12-15% | 12-15% | 15-20% | 10-12% |

The Indian semiconductor design market is dominated by embedded systems design with as much as 85-90% share of the revenue. VLSI (very large-scale integration and PCB (hardware & board design) together have not more than 15% of the share of revenue.

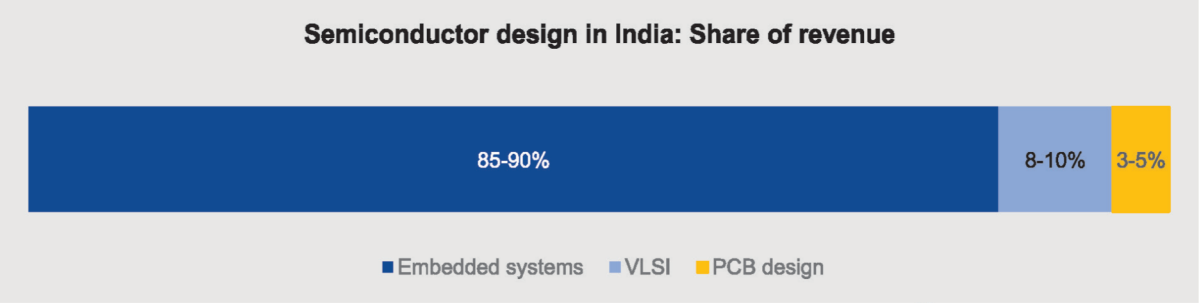



*Figure 13: Share of revenue for semiconductor design in India[22]*

[21] *https://iesaonline.org/images/Research/Exec-Summary-IESA-ESDM-report-Mar-2020.pdf, Kantar analysis.*
[22] *https://iesaonline.org/information-hub/indian-esdm-industry-update-an-iesa-ey-report*

It is estimated[23] that the total market for components in India in 2021-22 was around US$ 47 billion. The broad composition of this market is estimated to be as follows:

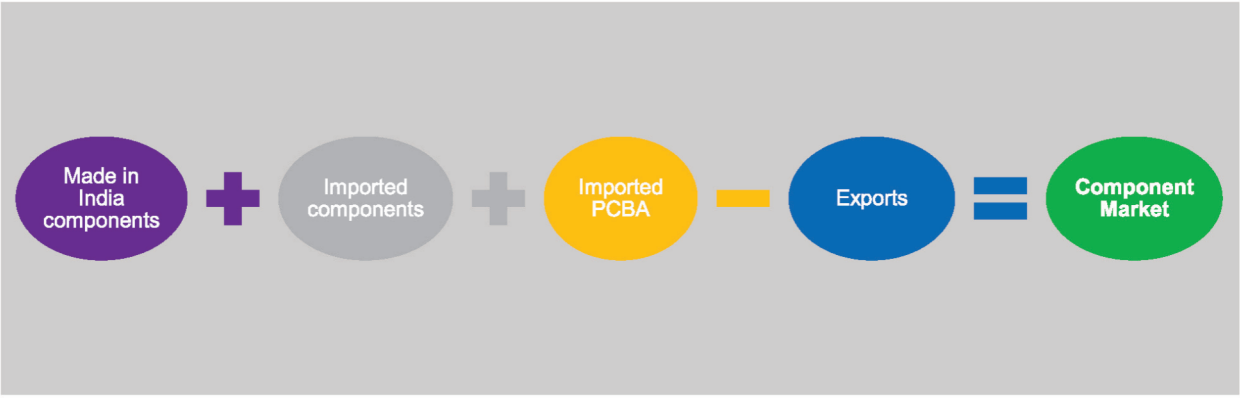



*Figure 14: Components Market in India (2021-22)*

The break-up of above market in detail is given in chart below:

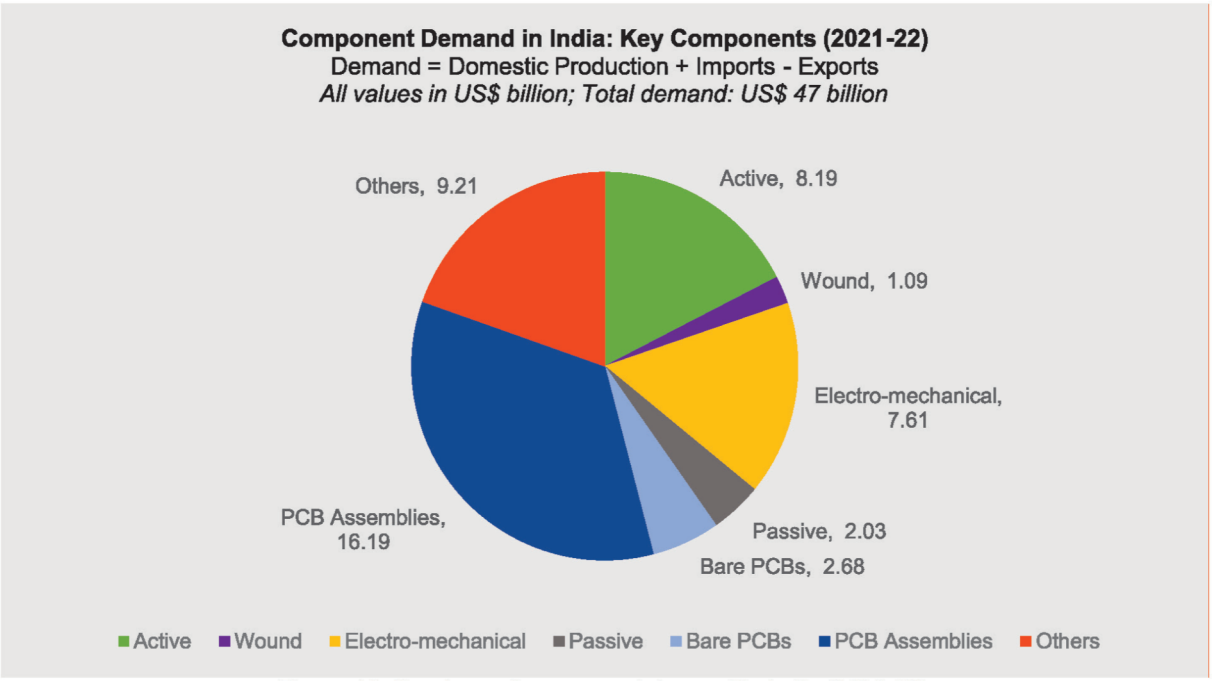



*Figure 15: Break-up of component demand in India (2021-22)*

PCB assemblies, which are almost wholly imported, form the biggest chunk of the component demand in India. This is followed by active components and then, electro-mechanical components. Passive components and wound components form a very low share of the overall component demand in India.

However, even in 2021, just below 10% of India's semiconductor requirements were sourced domestically[24]. One of the key inhibitors that the industry faces is threat from imports. A major reason why Indian firms are unable to effectively create an import substitution is the economic disability they face. This disability is to the tune of 10-12%[25]. However, the government is cognizant of this fact and is taking suitable steps to make India self-reliant in this space. For e.g., it launched the India

[23] *ELCINA Task Force Report on Electronics Components: State of Industry & Way Forward (15th December 2019), https://iesaonline.org/images/Research/Exec-Summary-IESA-ESDM-report-Mar-2020.pdf, Kantar analysis.*
[24] *https://www.business-standard.com/article/economy-policy/only-9-of-india-s-semiconductor-needs-fulfilled-locally-in-2021-iesa-122041800331_1.html*
[25] *Source : ELCINA*

Semiconductor Mission[26] in 2021 with an aim to provide financial support to companies in this sector. For this mission, a total outlay of INR 76,000 crores has been approved.

There are three key factors which would drive the growth of semi-conductors and components sector in India. The growth in sector will, in turn, lead to generation of jobs as estimated next.

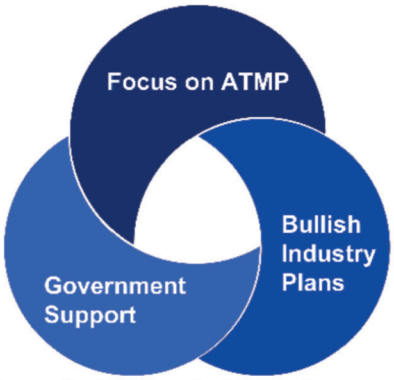



*Figure 16: Drivers of growth: Semiconductors and components industry in India*

These are discussed below:

1. **Government support:** Government of India is keen to support the semi-conductors and components sector in India and has, in the recent past, launched many schemes and plans to support the sector. Some of these include[27]:
    a. A comprehensive PLI (performance linked incentive) scheme was approved by MeitY (Ministry of Electronics & Information Technology) in December 2021. This was focussed on development of semiconductors and display manufacturing and incentives worth INR 76,000 Crores (US$ 9.81 billion), to be distributed over 2021-26, were earmarked.
    b. An India Semiconductor Mission (ISM), led by global industry experts, has been set up to act as a nodal agency for PLI semiconductor schemes.
    c. SPECS or Scheme for Promotion of Manufacturing of Electronic Components and Semiconductors (SPECS) was announced in April 2020 and provides a financial incentive of 25% on CAPEX for specific electronic goods, including electronic components, semiconductor/ display fabrication units, ATMP units, and specialized sub-assemblies. This scheme applies to a variety of cases such as new unit investments and capacity expansion, modernisation, and diversification of existing units.
    d. Scheme for setting up of semiconductor fabs and display fabs extends fiscal support of up to 50% of project cost to execute highly capital and resource intensive projects. Both the Union and state governments will work together to establish high-tech clusters with state-of-the-art infrastructure in terms of land, semiconductor grade water, power, logistics and research ecosystem.
    e. Government has also approved the modernization and commercialization of semiconductor laboratory (SCL), Mohali, including a possibility of a joint venture with a commercial fab partner.
    f. Scheme for setting up of compound semiconductors / silicon photonics / sensors and semiconductor ATMP/OSAT facilities will extend fiscal support of around 30% of CAPEX.
    g. A design linked incentive (DLI) scheme extends product design linked incentive of up to 50% of eligible expenses and an incentive of 4-6% on net sales for 5 years. This is focussed on at least 100 domestic companies in this sector.

2. **Focus on ATMP:** While India is already a hub for fabless / design phase of the value chain, as per industry experts[28], these design capabilities make India ideally suited for venturing into

[26] *https://www.drishtiias.com/daily-updates/daily-news-analysis/india-semiconductor-mission*
[27] *https://www.ibef.org/blogs/india-s-progress-in-electronic-components-semiconductor-manufacturing, https://www.meity.gov.in/esdm/Semiconductors-and-Display-Fab-Ecosystem*
[28] *https://www.electronicsb2b.com/editors-choice/atmps-founding-stone-indias-semiconductor-era/*

ATMP/OSAT space. ATMP/OSAT companies require less capital and resources as compared to a full-fledged foundry and could pave the way towards India, eventually, hosting its own fab/foundry ecosystem. Further, ATMP units generate more employment than fab units[29]. Some interesting news on this front include:

a. Tata Group has announced its interest in entering the semiconductor space with an OSAT venture[30].
b. Visicon, promoted by Dr. Harshad Mehta (head of Silicon Power), is also planning to start at ATMP unit in India. The vision is to establish a 'silicon carbide ecosystem including silicon carbide EPI, silicon carbide processing, and packaging'[31].
c. Top global companies in ATMP space, viz., ASE Technology Holding (Taiwan), Powertech Technology (Taiwan), SPIL (Taiwan) and Amkor Technology (US), have held discussions with government to set up their manufacturing units in India[32].

3. **Bullish Industry Plans:** Many industry majors, both global and Indian, are planning a foray or expansion in this space in India. Some examples include[33]:
   a. Next Orbit Ventures (based in Abu Dhabi) and Israel's Tower Semiconductor have announced a joint venture, called ISMC, which has already signed an MoU with Karnataka government to set up a semiconductor chip manufacturing plant in the state. New Orbit Ventures also plans to invest US$ 100 million in a semiconductor fabrication project in Gujarat.
   b. Freescale, a US based semiconductor company with R&D centre in India has enabled its partners to launch smart products to support the Digital India initiative.
   c. Aricent, a US based firm, has acquired SmartPlay, a Bengaluru based chip design services company, for INR 1,100 crores (US$ 163 million). This is one of the biggest acquisitions in semiconductor space in India.
   d. Invecas Technologies, an outsourced chip design startup, plans to invest US$15-20 million to set up design centres in Hyderabad and Bengaluru.
   e. German firm, Infineon Technologies, has partnered with NSDC to impart training on semiconductor chip technology to bridge the skill gaps among youth in this sector.

It is estimated[34] that the PLI and DLI schemes announced by the government, to incentivise semiconductor manufacturing, will attract a CAPEX of around INR 4 trillion over the next five years and has the potential to generate employment of more than 3 million skilled and unskilled workers in this sector. This is in addition to the technical and managerial roles within the sector.

## Manpower requirement

Semiconductors and components is estimated to employ around 1.39 Lacs personnel in the year 2021-22[35]. This is up from 1.05 Lacs personnel in the year 2018-19 and has been growing at a rate of around 10% (CAGR).

As per industry experts interviewed by Kantar, the manpower growth is likely to be in the region of 30-40% (and even upwards). However, as per Kantar estimates, a realistic scenario would be a growth rate of around 18-22% in the manpower requirement. Considering this growth rate, it is expected that by the year 2025-26, semi-conductor and components sector would employ close to 3 Lacs people in various roles.

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[29] *https://www.livemint.com/technology/tech-news/indias-journey-in-chip-making-may-start-with-atmps-11623259001571.html*
[30] *https://www.electronicsb2b.com/editors-choice/atmps-founding-stone-indias-semiconductor-era/*
[31] *https://www.electronicsb2b.com/editors-choice/atmps-founding-stone-indias-semiconductor-era/*
[32] *https://www.business-standard.com/article/companies/semiconductor-assembly-majors-plan-to-set-up-manufacturing-units-in-india-120061300035_1.html*
[33] *https://www.ibef.org/industry/semiconductors.aspx, https://www.ibef.org/blogs/india-s-progress-in-electronic-components-semiconductor-manufacturing*
[34] *https://timesofindia.indiatimes.com/blogs/voices/semiconductor-push-employment-opportunities-for-the-future/*
35 *https://www.essc-india.org/wp-content/uploads/Feedback_ESSCI_Book_V4_10092019.pdf, Kantar analysis*

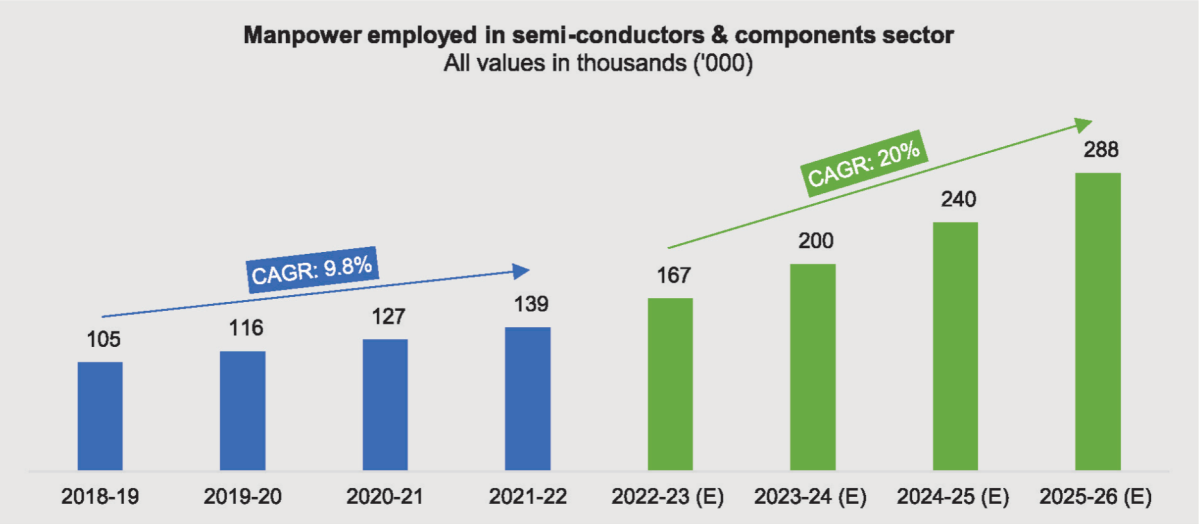



*Figure 17: Manpower employed in semi-conductors and components sector (FY 2018 to FY 2025)*

Future estimates of manpower have been derived basis two methods as shown below:

**Historic Growth Rate**

Historic growth rate of manpower in semiconductor and components sector is around 10%. Given the good growth outlook of the sector at least this growth can be expected. This, therefore, would be the pessimistic scenario.

**Expected Growth Rate**

As per industry experts, manpower intake in the next few years in the semiconductors and components sector can be as high as 30-40%. This can be considered as an optimistic scenario.

A bulk of manpower, around 55%, is employed in design and research & development roles as well as those in managerial roles such as business development and marketing. Around 30% of the manpower is in manufacturing, assembly & testing roles and 15% in quality assurance/control roles as well as other service roles such as after-sales services.

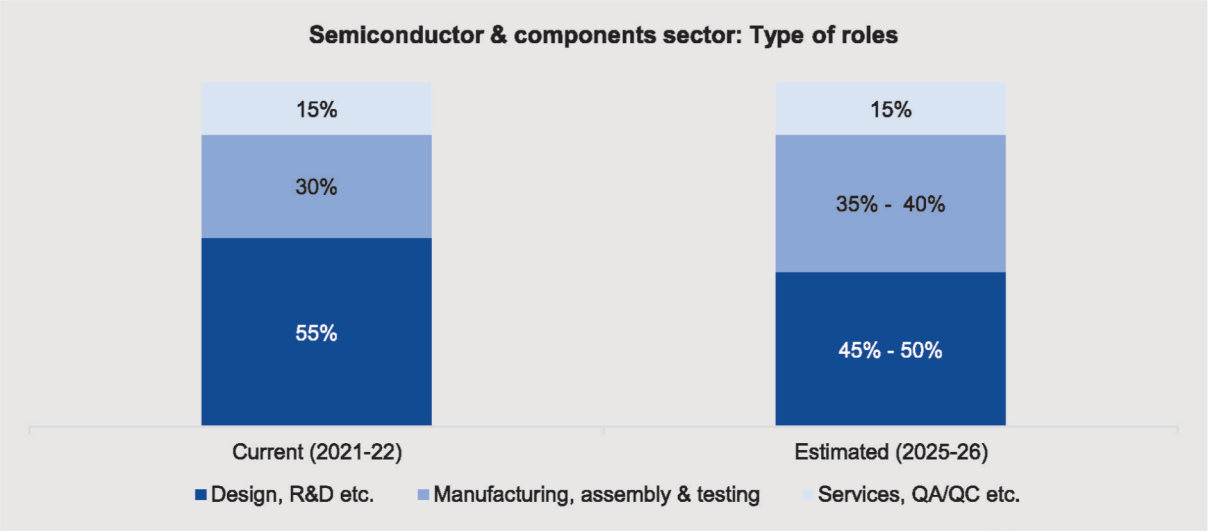



*Figure 18: Manpower in semiconductor & components sector: Type of roles*[36]

However, as the manufacturing component of the industry gains traction – driven by factors highlighted above – the share of manufacturing roles in the manpower pool will grow and is expected to reach around 35-40% by 2025-26 from current 30%.

Chart below shows the manpower requirement for semiconductors sector as well its broad bifurcation into various role types such as design, R&D, manufacturing, assembly & testing as well as services such as QA/QC etc.

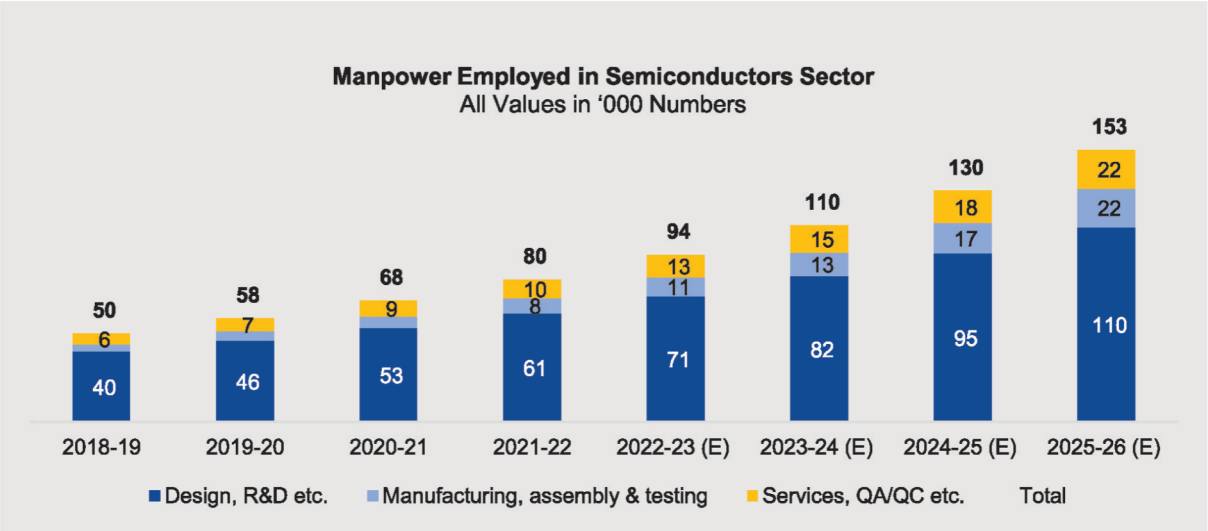



*Figure 19: Manpower in semiconductors sector: Total and type of roles*[37]

Around 80% of the manpower is currently in permanent job roles while just around one-fifth serving in contractual roles. This indicates low level of manufacturing in this sector in India.

[36] *Source: Kantar primary survey.*
[37] *Source: Kantar analysis based on primary survey.*

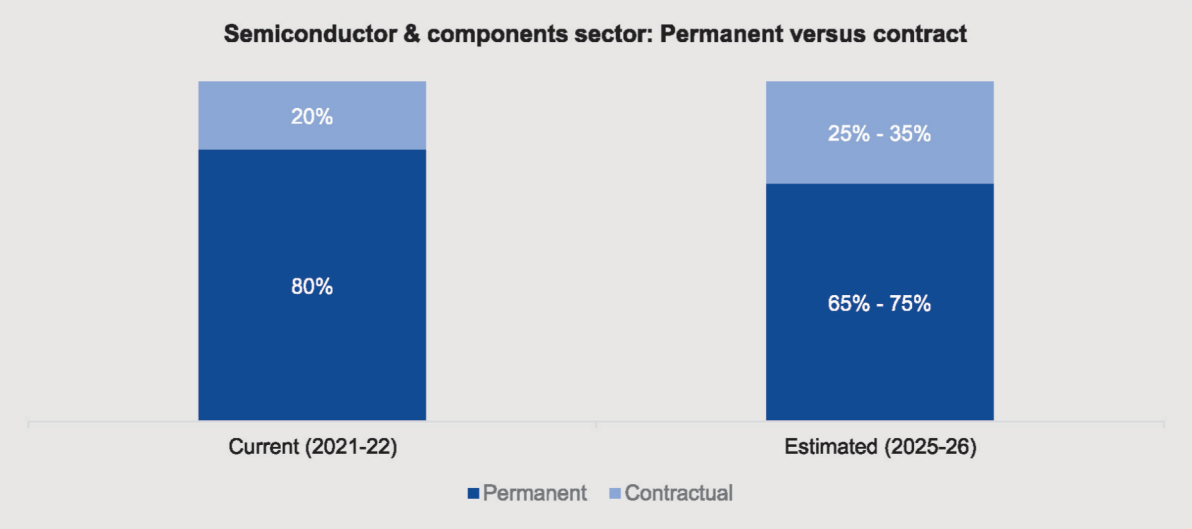
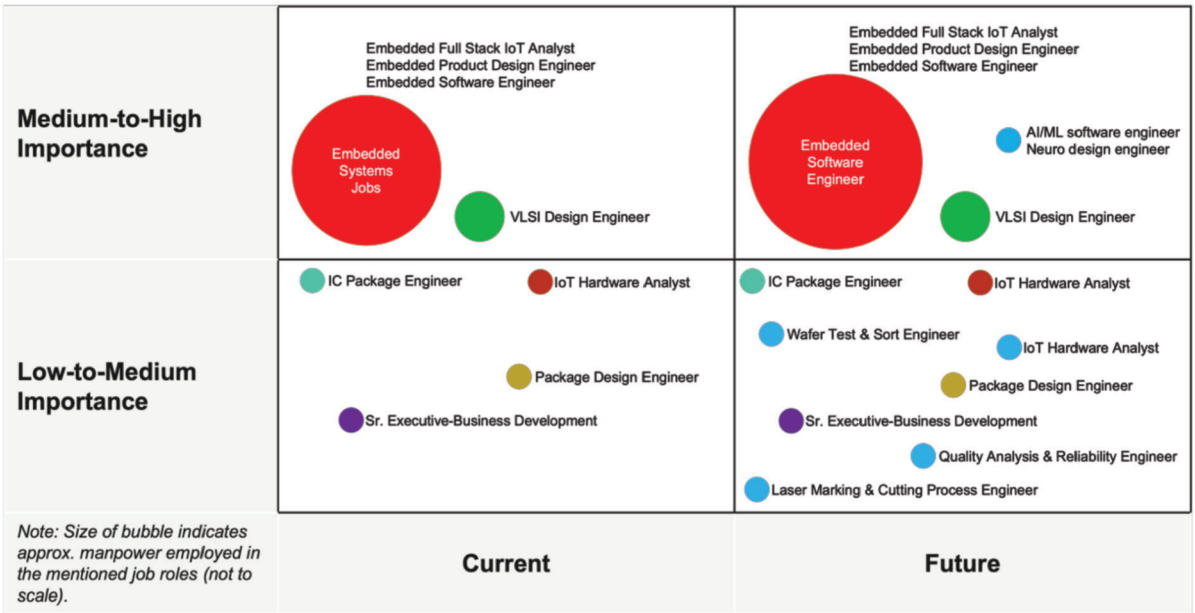



*Figure 20: Manpower in semiconductor & components sector: Permanent versus contract*[38]

However, again, driven by manufacturing, the contractual roles' share in the manpower pool will grow over the next 4-5 years and is expected to reach around 25-35% from current 20%.

Bulk of semiconductors jobs are in design and research & development and very few in manufacturing, assembly & testing (as shown in picture below).




Jobs related to embedded systems and VLSI design are the ones employing the most manpower in semiconductor design category. These are also the ones which are medium to high in importance. In fact, their importance is only likely to grow in future. Other jobs which would emerge in future would be:

- AI/ML based software engineer
- Neuro design engineer

However, even in next five years, jobs related to embedded systems would employ most people.

Chart below shows the manpower requirement for components sector as well its broad bifurcation into various role types such as design, R&D, manufacturing, assembly & testing as well as services such as QA/QC etc.

[38] *Source: Kantar primary survey.*

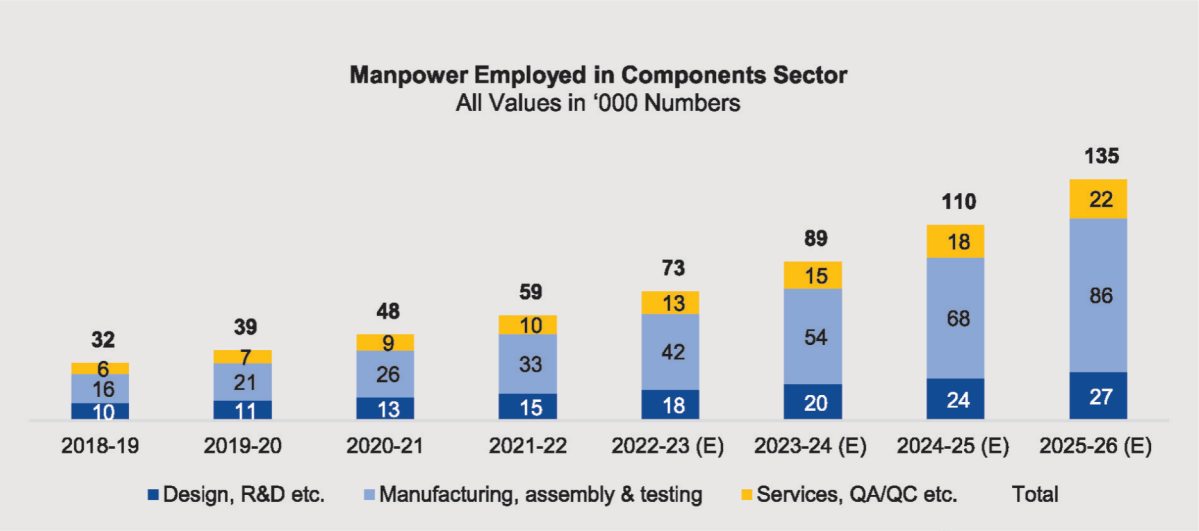
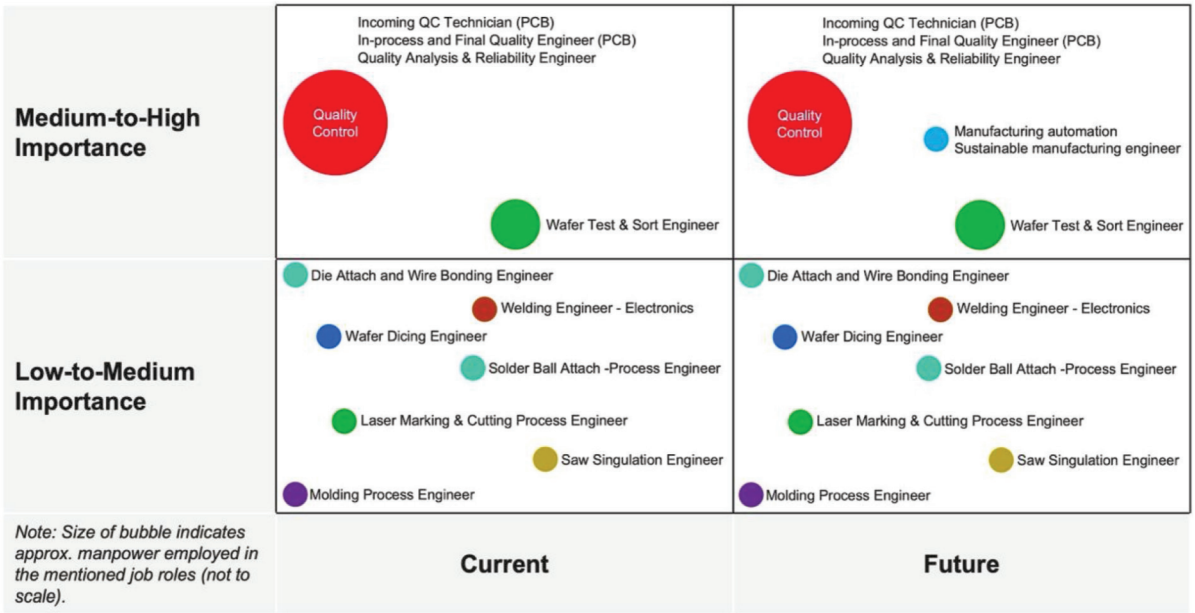



*Figure 21: Manpower in components sector: Total and type of roles*[39]

Bulk of components jobs are in manufacturing, assembly & testing while very few are in design, R&D etc.

Jobs related to quality control and testing are the ones employing the most manpower in components manufacturing category (as shown below):




These are also the ones which are medium to high in importance. In fact, their importance is only likely to grow in future. Other jobs which would emerge in future would be:

- Manufacturing automation
- Sustainable manufacturing engineer

[39] *Source: Kantar analysis based on primary survey.*

# Major job roles, required skills and upskilling practices

## Major job roles

Major job roles in semiconductor and components sector are listed below[40]:

*Figure 22: Job roles relevant for semiconductors and components sector[41]*

| Design, R&D Etc. | Manufacturing, Assembly & Testing | Services, QA/QC Etc. |
|---|---|---|
| — Embedded Full Stack IoT Analyst<br>— Embedded Product Design Engineer-Technical Lead<br>— Embedded Software Engineer<br>— IC Package Engineer<br>— IoT Hardware Analyst<br>— Package Design Engineer<br>— Sr. Executive-Business Development<br>— VLSI Design Engineer<br>— Baseband Designer / RF Designer, Power Designer, General Board Designer, Low Power Designer.<br>— Automation Expert | — Die Attach and Wire Bonding Engineer<br>— Laser Marking & Cutting Process Engineer<br>— Moulding Process Engineer<br>— Saw Singulation Engineer<br>— Solder Ball Attach -Process Engineer<br>— Wafer Back Grinding Engineer<br>— Wafer Dicing Engineer<br>— Wafer Test and Sort Engineer<br>— Welding Operator Electronics<br>— Winding Operator<br>— Process Engineer / Process Design Engineer<br>— Manufacturing Maintenance Engineer | — Failure Analysis & Reliability Engineer<br>— Quality Analysis & Reliability Engineer |

Top job roles which are critical for smooth functioning of core operations in semi-conductors & components company are listed below along with their minimum requirements (in terms of education and experience). The table also shows the expected future trajectory – i.e., their importance or criticality in future.

*Figure 23: Top job roles critical in semiconductors & components sector*

| **Top Job Roles** *(In Order of Importance)* | **Function** | **Minimum Requirements Necessary** *(Education and Experience)* | **Expected Future Trajectory/Importance** |
|---|---|---|---|
| Quality Analysis & Reliability Engineer | Services, QA & QC Etc. | **Education:** Graduation (Technical); For e.g., B.E., B.Tech.<br>**Experience:** Between 3 to 10 years. | Highly likely to increase in importance. |
| Very Large-Scale Integration (VLSI) Design Engineer | Design and R&D | **Education:** Graduation (Technical); For e.g., B.E., B.Tech., Preferred: Post-Graduation (Technical) For e.g., M.E., M.Tech.<br>**Experience:** 1 to 10 years. | Quite likely to increase in importance. |
| Wafer Test & Sort Engineer | Manufacturing | **Education:** Graduation (Technical); For e.g., B.E., B.Tech., Preferred: Post- | Either would remain same in importance or would increase in importance. |

[40] *Source: ESSCI*
[41] *Source: ESSCI*

| Top Job Roles *(In Order of Importance)* | Function | Minimum Requirements Necessary *(Education and Experience)* | Expected Future Trajectory/Importance |
|---|---|---|---|
| | | Graduation (Technical) For e.g., M.E., M.Tech. **Experience:** 1 to 10 years. | |
| Embedded Product Design Engineer – Technical Lead | Design | **Education:** Graduation (Technical); For e.g., B.E., B.Tech., Preferred: Post-Graduation (Technical) For e.g., M.E., M.Tech. **Experience:** Usually 3 to 5 years. | Either would remain same in importance or would increase in importance. |
| Embedded Full Stack IoT Analyst | Design | **Education:** Minimum Class X or XII with ITI. Preferred: Diploma/Degree in Electrical or Electronics Engineering. **Experience:** Minimum 2 to 4 years depending upon qualification. | Quite likely to increase in importance. |
| Embedded Software Engineer | Design | **Education:** Graduation (Technical); For e.g., B.E., B.Tech., Preferred: Post-Graduation (Technical) For e.g., M.E., M.Tech. **Experience:** Generally 5+ years. | Likely to remain same in importance. |
| Package Design Engineer | Design | **Education:** Any graduation (technical / non-technical). **Experience:** 1 to 10 years. | Either would remain same in importance or would increase in importance. |

All the above job roles exist in varying numbers in semiconductor and components companies. These may, therefore, contribute to around 10-20% of total manpower of a company. As an industry, these together, may contribute to around 50-60% of the total manpower.

A sample occupational map of some of the key job roles above is given below:

*Figure 24: Sample occupational map for a few illustrative job roles in semiconductors and components sector*

| Job Role | VLSI Design Engineer | Moulding Process Engineer | Quality Analysis & Reliability Engineer |
|---|---|---|---|
| **Category** | Design, R&D Etc. | Manufacturing, Assembly & Testing | Services, QA/QC Etc. |
| **Education** | Graduation (Technical); For e.g., B.E., B.Tech., Preferred: Post-Graduation (Technical) For e.g., M.E., M.Tech. | Minimum 3 years diploma (after class XII). Preferred: B.E./B.Tech. in Electronics or Electrical Engineering. | Graduation (Technical); For e.g., B.E., B.Tech. |
| **Experience** **Skills** | Between 1 to 10 years. STA, FGPA Design, VLSI, analog layout, design analysis, backend design flow. | Between 1 to 3 years. Unigraphics (UG), Mould Flow software, Automobile OEM industry/Mould maker industry. | Between 3 to 10 years. Understanding of semiconductor device physics, MOSFET working principles, and fabrication processes. |

There are also some minor roles which are considered important in the industry. These include that of Incoming QC Technician (PCB), Quality Analysis & Reliability Engineer and Sr. Executive-Business Development. Each of these job roles contribute, typically, to less than 5% of manpower in the company.

Some job roles which are expected to rise in future include:

- AI/ML based software engineer
- Neuro design engineer
- Manufacturing automation
- Sustainable design and/or manufacturing engineer

## Critical skills: Technical

Some of the key skills required for major job roles in this sector are listed below:

*Figure 25: Top skills required for major job roles in semi-conductors and components sector*

| Job Category | Job Roles | Key Skills[42] |
|---|---|---|
| **Design, R&D Etc.** | Embedded Software Engineer | Embedded protocols like UART, SPI, I2C etc., knowledge of multi-meter & oscilloscope. |
| | VLSI Design Engineer | STA, FGPA Design, VLSI, analog layout, design analysis, backend design flow. |
| | Baseband Designer / RF Designer, Power Designer, General Board Designer, Low Power Designer | Power delivery network design of SOC, programming skills, circuit simulation tools. |
| | Automation Expert | Knowledge of software, hardware and other tools used in automation. |
| **Manufacturing, Assembly & Testing** | Die Attach and Wire Bonding Engineer | Mechanical / electronics/ electronics packaging or equivalent. |
| | Moulding Process Engineer | Unigraphics (UG), Mould Flow software, Automobile OEM industry/Mould maker industry. |
| | Saw Singulation Engineer | Knowledge of complete process of Saw Singulation during IC packaging. |
| | Solder Ball Attach - Process Engineer | Knowledge regarding requirements of process engineering, applicable local and international standards and statutory and regulatory specifications. |
| | Manufacturing Maintenance Engineer | Mechanical, preventive maintenance, safety, troubleshooting, PLC, continuous improvement facilitation, plant maintenance, maintenance and engineering |
| **Services, QA/QC Etc.** | Quality Analysis & Reliability Engineer | Understanding of semiconductor device physics, MOSFET working principles, and fabrication processes. |

Apart from the above specific job-role wise skills, in view of employees, top five general technical skills considered critical in semi-conductors and components sector include knowledge of an in-depth technical knowledge of computer hardware and software systems as well as that of electronics and electrical systems. This is followed by knowledge of circuit design, information technology & information systems as well as testing.

[42] *Sources: LinkedIn, Naukri.com, Kantar primary research.*

*Figure 26: Top technical skills critical for semiconductors & components sector*

| Rank | Technical Skills *(Ranked in terms of number of personnel with skill required)* | Relevance *(For Job Security)* | Relevance *(For Job Promotions)* | Current Readiness |
|---|---|---|---|---|
| 1 | Technical knowledge: Computer hardware & software | Medium | Medium | High |
| 2 | Technical knowledge: Electronics & electrical systems | High | High | High |
| 3 | Circuit design | Medium | Medium | High |
| 4 | Information technology / systems | Medium | High | Medium |
| 5 | Testing | High | High | Medium |

While technical knowledge of electronics & electrical systems as well as testing have a high relevance for job security and promotions in job, other skills can be said to be medium relevant on these aspects. Personnel currently employed in this sector feel that they have a reasonably high level of readiness on technical knowledge of computer hardware & software as well as electronics & electrical systems and circuit design. There is a medium level of readiness on information technology & information systems as well as testing.

## Critical skills: Non-technical

Top five non-technical skills required for major job roles in semi-conductors and components sub-sector include problem identification & solving, project management &/or production management, leadership & team management, communication skills and product development and management.

| Rank | Non-Technical Skills *(Ranked in terms of number of personnel with skill required)* | Relevance *(For Job Security)* | Relevance *(For Job Promotions)* |
|---|---|---|---|
| 1 | Problem identification & solving | High | High |
| 2 | Project management and/or production management | High | Medium |
| 3 | Leadership and team management | High | Medium |
| 4 | Communication skills | Medium | Medium |
| 5 | Product development and management | Medium | Medium |

The soft skills of problem identification & solving is considered highly relevant for both job security and job promotions – thereby highlighting logical mindset in these roles. Project and/or production management and leadership & team management are considered to be necessary skills with high relevance for job security but medium relevance for job promotions. Communications skills and product development & management skills both have medium relevance for job security as well as job relevance.

## Training practices: Internal and/or external

Only around 25% companies in semi-conductors & components sub-sector feel that their newly hired employees are fully job-ready who require no training. Almost half feel that while they are somewhat ready but do require some training.

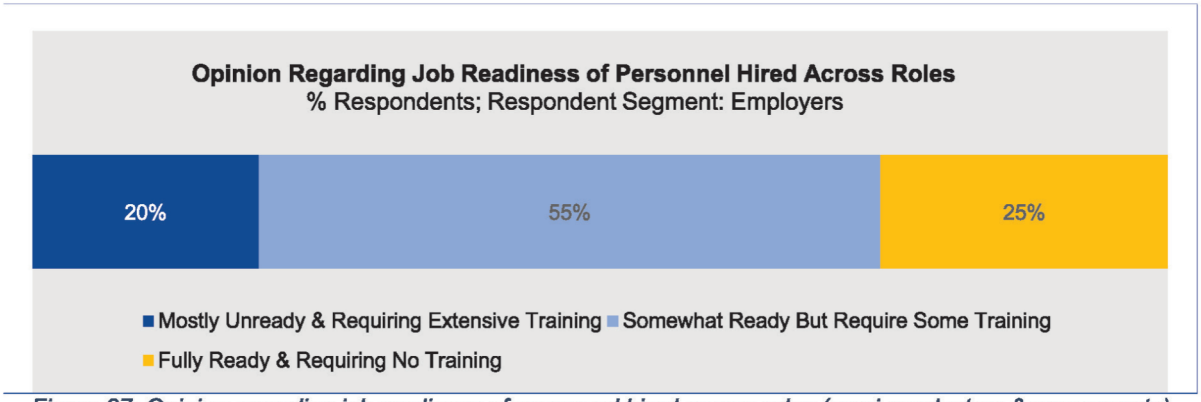



*Figure 27: Opinion regarding job readiness of personnel hired across roles (semi-conductors & components)*

Most of these companies provide on-job training to their employees to gain skills which are necessary for being job-ready. Close to half the companies also provide orientation training upon joining while around 20% also consider other industry/lab visits.

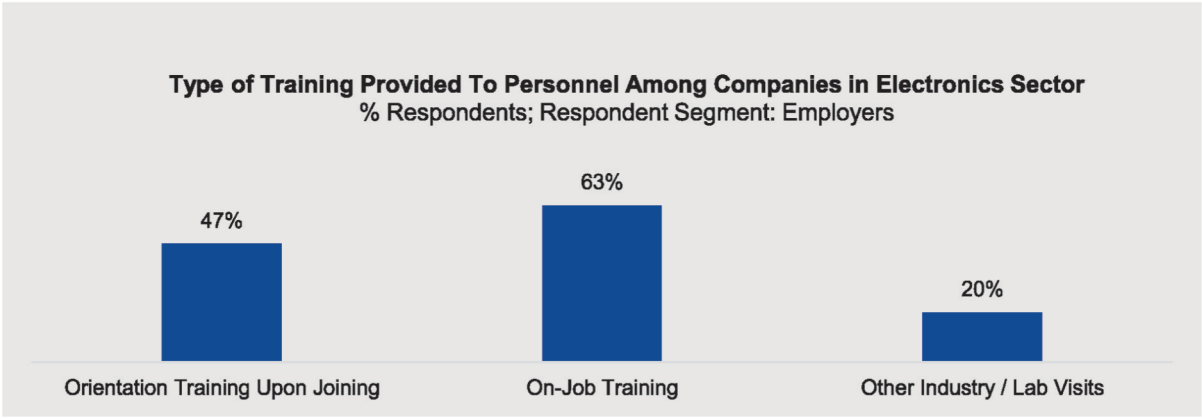



*Figure 28: Type of training provided to personnel by companies in electronics sector (semi-conductors & components)*

Orientation training duration in companies operating in semi-conductors & components sector is quote long – even many months – in duration. More than 80% companies give training which is more than 2 months long.

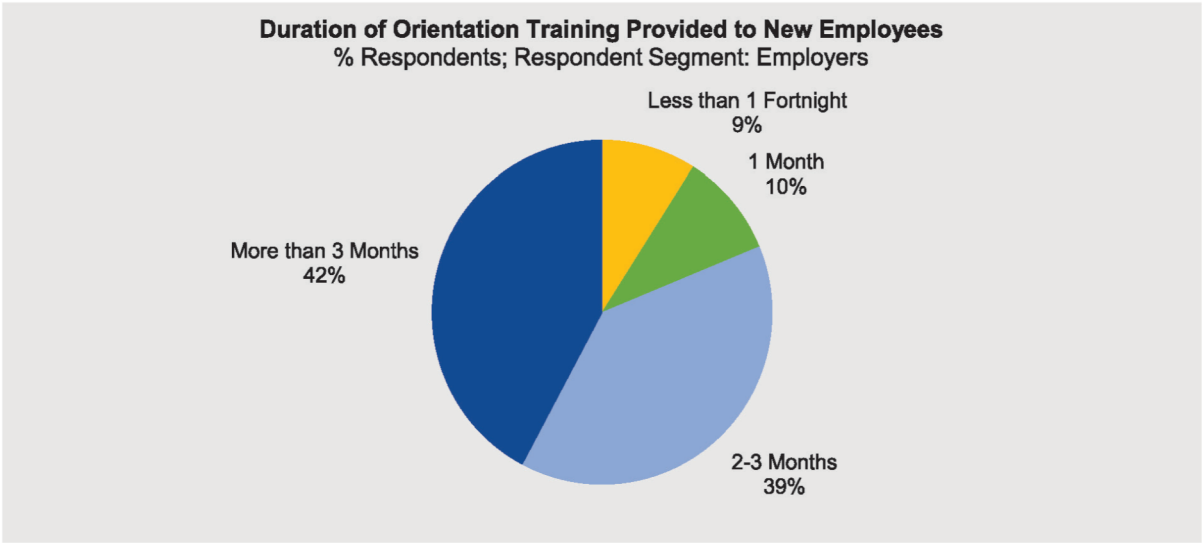



*Figure 29: Duration of orientation training provided to new employees by companies (semi-conductors & components)*

There are over 375 training institutes, across India, which have partnered with ESSCI to provide training to personnel for becoming job ready in electronics sector. Top-5 courses (in terms of absolute enrolment), in semi-conductors and components segment, for which these training institutes provide training include Embedded Software Engineer, PCB Design Engineer, VLSI Design Engineer and Winding Operator.

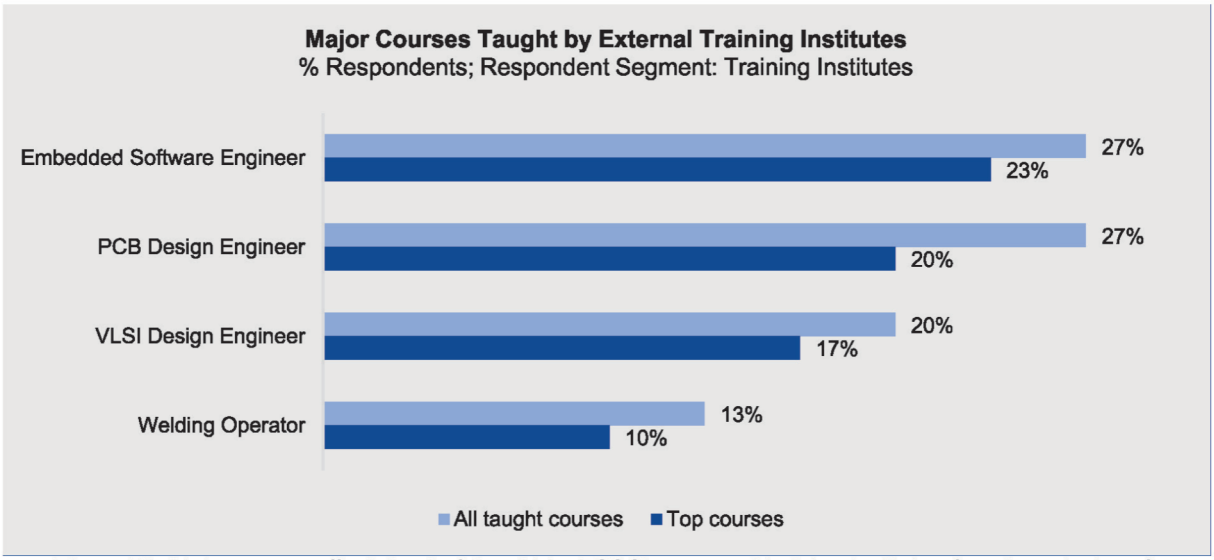



*Figure 30: Major courses (for job roles) taught by ESSCI approved training institutes (semi-conductors & components)*

In view of external training institutes, job roles in semiconductor & components sub-sector, which hold top importance are Verification Engineer, VLSI Design Engineer and Embedded Software Engineer. Not only are these job roles high in demand among trainees, as shown by enrolment levels to the training courses, but are also deemed highly relevant for job prospects, security and promotion by these training institutes.

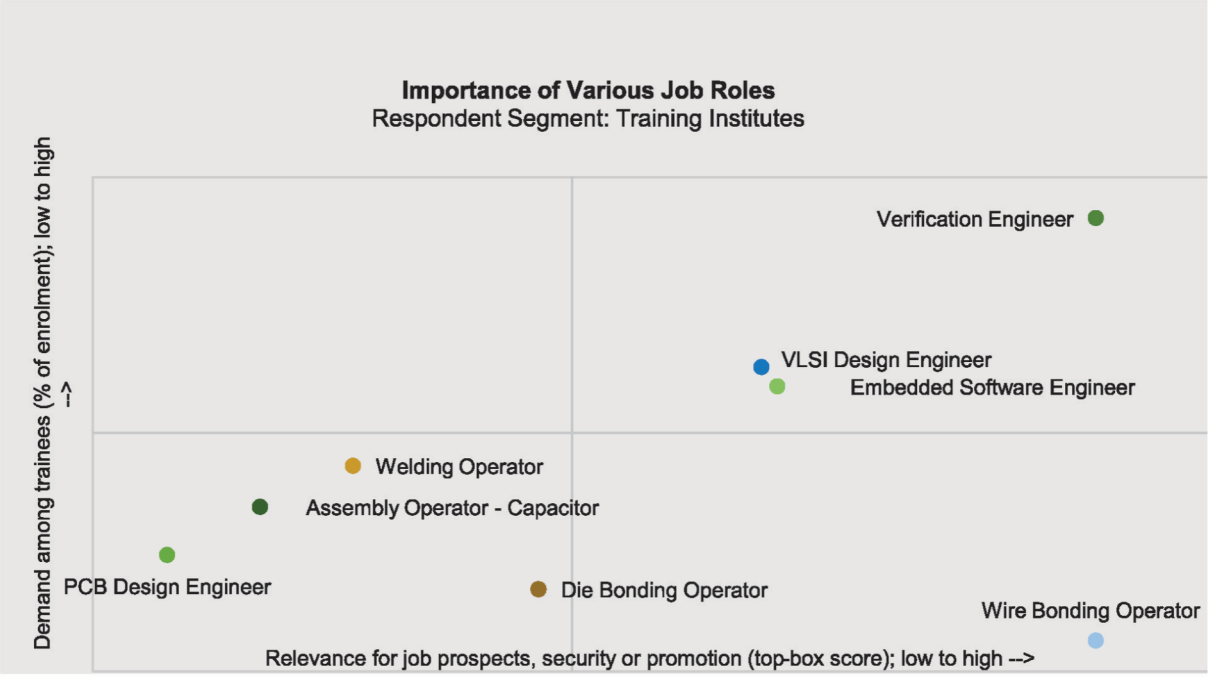



*Figure 31: Importance of various job roles (semi-conductors & components)*

In view of these training institutes, the top reason for low demand, among students/trainees, for some of these courses is the high cost of training followed by low demand among students.

The two key challenges which training institutes face in providing training in semiconductor & components sub-sector are quality and availability of instructors as well as demand for courses/programs among students.

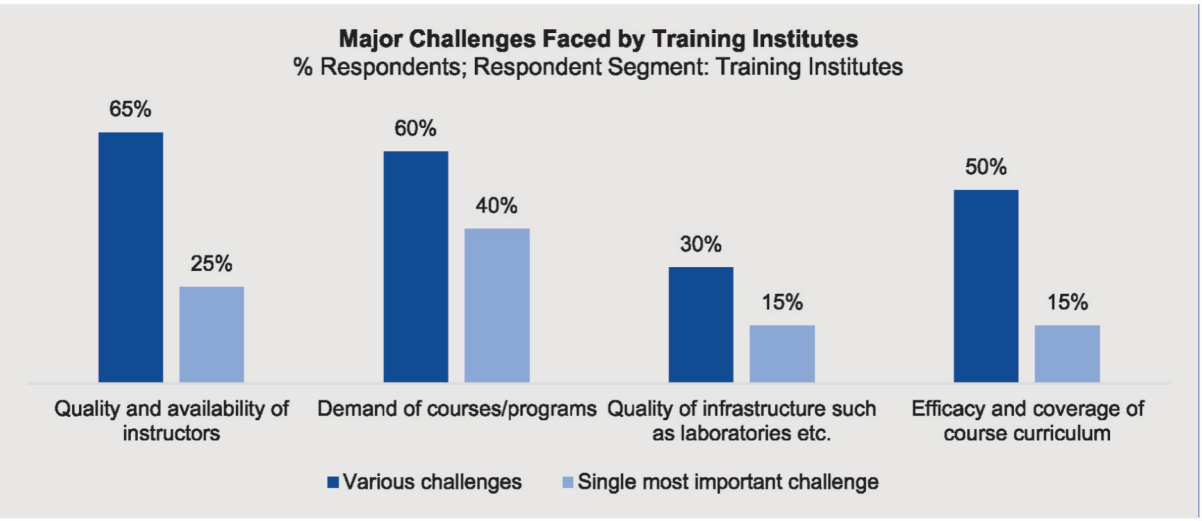



*Figure 32: Challenges faced by training institutes (semi-conductors & components)*

While considering their experience with external institutes/facilities for skill development for their industry, industry leaders in the semi-conductors & components sub-sector are, generally, satisfied with the quality of labs & equipment at these institutes as well as their level of industrial collaboration. However, there are some need gaps around training cost, quality of instructors/trainers as well as training efficacy for job readiness.


*Figure 33: Level of satisfaction with external training institutes (semi-conductors & components)*

## Upskilling practices by employees

Employees in various companies operating in electronics manufacturing sector actively strive to keep themselves upskilled in order to remain relevant in the ever-changing job market. However, they face multiple challenges to remain upskilled. The most common challenges faced by them are the lack of time and a lack of funds. Many of them also feel that there is a lack of availability of training resources – whether within organization or outside it.


*Figure 34: Challenges faced by employees to remain upskilled (semi-conductors & components)*

The largest mode of training received by employees in their company is through company training portal (or other online training courses funded by the company) followed by on-job training.

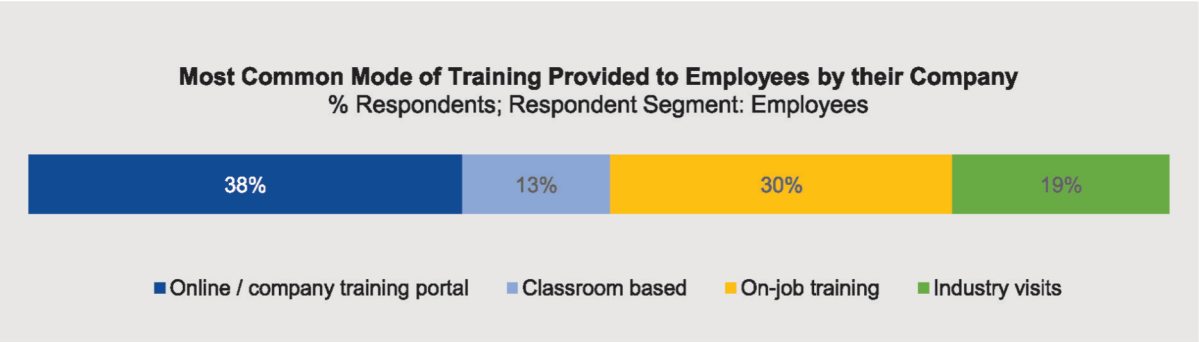



*Figure 35: Common modes of training provided to employees by companies (semi-conductors & components)*

Most employees not only find the coverage of course curriculum, of in-house training, adequate but also relevant for increasing their efficiency and efficacy in their jobs.

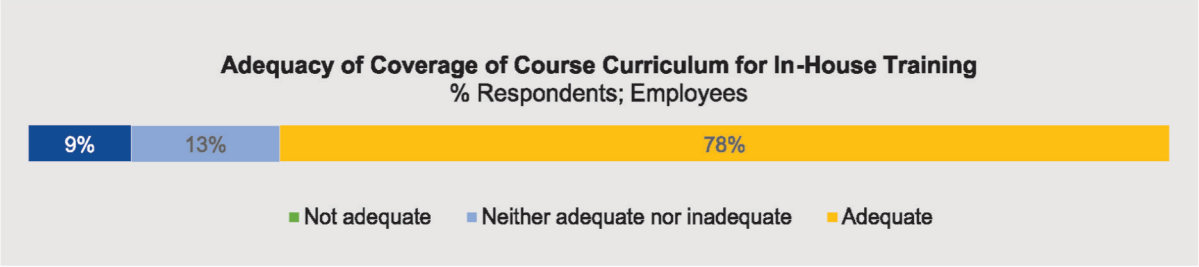



*Figure 36: Adequacy of coverage of course curriculum for in-house training (semi-conductors & components)*


*Figure 37: Relevance of in-house training in increasing efficiency & efficacy of employees (semi-conductors & components)*

Apart from being trained by their company, many of these employees also use external sources of training – most commonly being online/MOOC courses available on Coursera, Unacademy, eDX etc. – to remain upskilled. Many of them also taken for industry visits by their companies (or, rarely, on self-initiative).

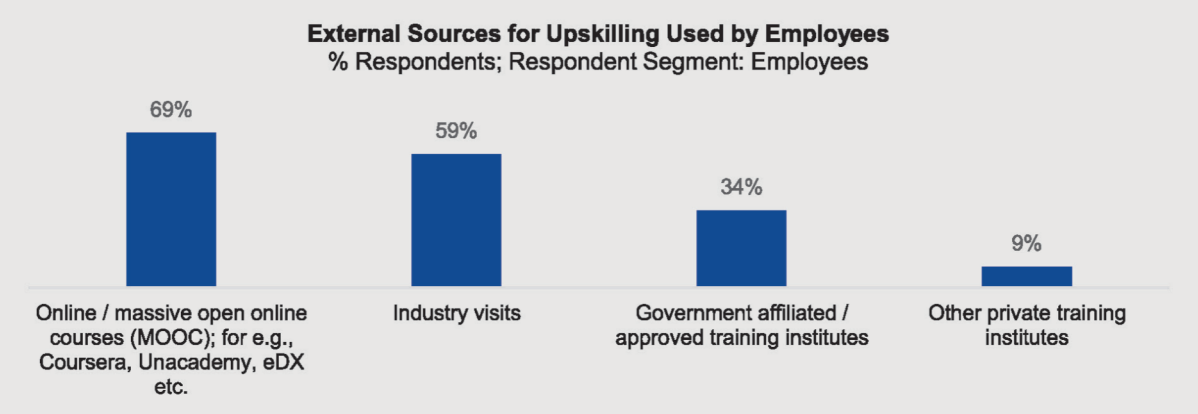



*Figure 38:External sources of training used by employees for upskilling (semi-conductors & components)*

Industry visits, followed by government approved training institutes, are generally considered the best in terms of their coverage of training material. Interestingly, while online/MOOC courses are preferred by a large percentage of employees, very few find the coverage there as excellent.

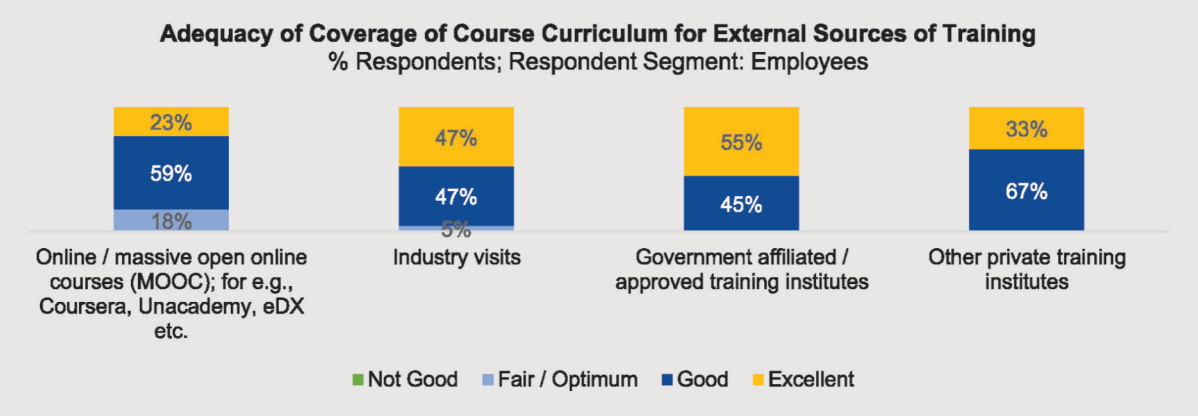



*Figure 39: Adequacy of coverage of course curriculum for external training (semi-conductors & components)*

Training and experience provided by industry visits are also considered among the best for increasing efficiency and efficacy of their jobs.

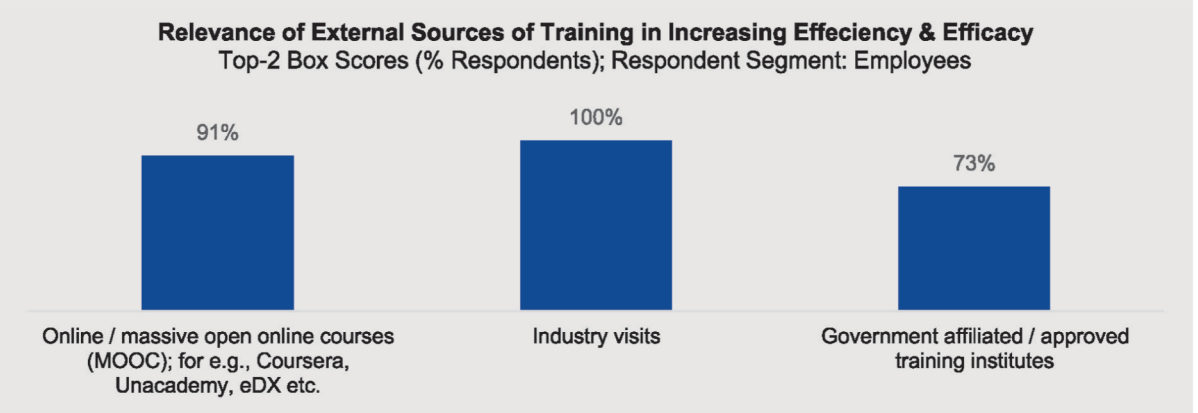



*Figure 40: Relevance of external training in increasing efficiency & efficacy of employees (semi-conductors & components)*

# Electronics Manufacturing Services (EMS)

## Introduction

The global EMS market is made up of companies who manufacture electronic products for OEMs and major brands. They can range from assembling components on PCBs to complete system integrations. The EMS companies provide value to the OEMs by standardizing and streamlining the process. Some of the services provided by EMS companies can go beyond only manufacturing and may include design and development, testing, and aftersales services. This frees up resources for OEMs and allows them to focus on innovating.

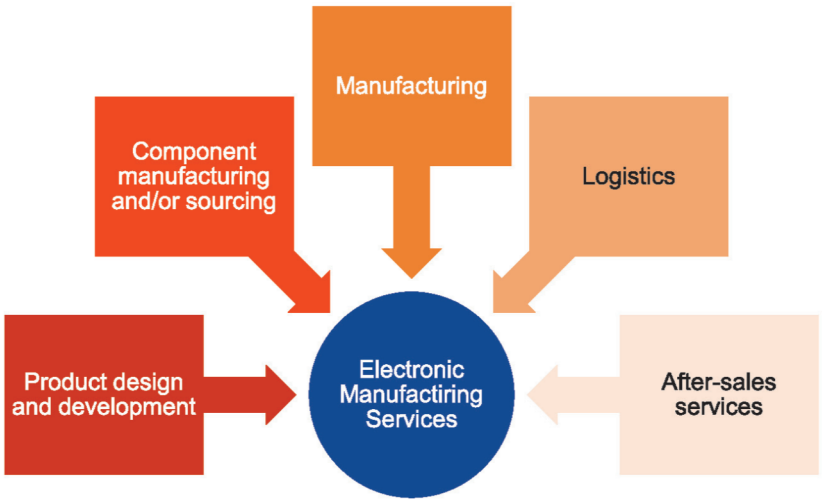



*Figure 41: Services provided by EMS companies globally*[43]

These services are explained below:

1. **Product design & development** comprise of designing of electronics products as per OEM specifications and include product development, prototyping etc.
2. **Component manufacturing and sourcing** comprising of buying electronic components for the purpose of their assembly on a printed circuit board.
3. **Manufacturing and/or assembly** could either refer to PCBA (printed circuit board assembly) or box-build assembly i.e., systems integration.
4. EMS companies are also engaged in **logistics** of component sourcing or finished product delivery as well as **after-sales services** such as repair and maintenance of the products.

Not all the above services are provided by all EMS companies. While large EMS companies have capabilities to provide the entire range of the above services, most small and medium sized EMS companies focus on providing assembly and testing services.

## EMS industry: global scenario

The Electronic Manufacturing Services (EMS) Industry is estimated to be around US$ 836 billion in the year 2021-22. It has grown at a CAGR of just over 2% since 2017-18. The industry was hit by decline in global automotive sales as well as plateauing consumer electronics sales. However, multiple factors such as release of pent-up demand as well as creation of new demand due to emergence of work-from-home economy (leading to demand of computer and its peripherals) are likely to increase this growth sharply to just below 5% during the next 4-5 years. Other factors include attributed increase in automotive, healthcare, and industrial applications. It is, therefore, estimated that the global EMS industry will cross US$ 1 trillion by 2025-26.

[43] *https://www.bharatfih.com/wp-content/uploads/2021/12/Bharat-FIH_Indian-EMS-ODM-Industry-Report_Final_21-December-21.pdf*

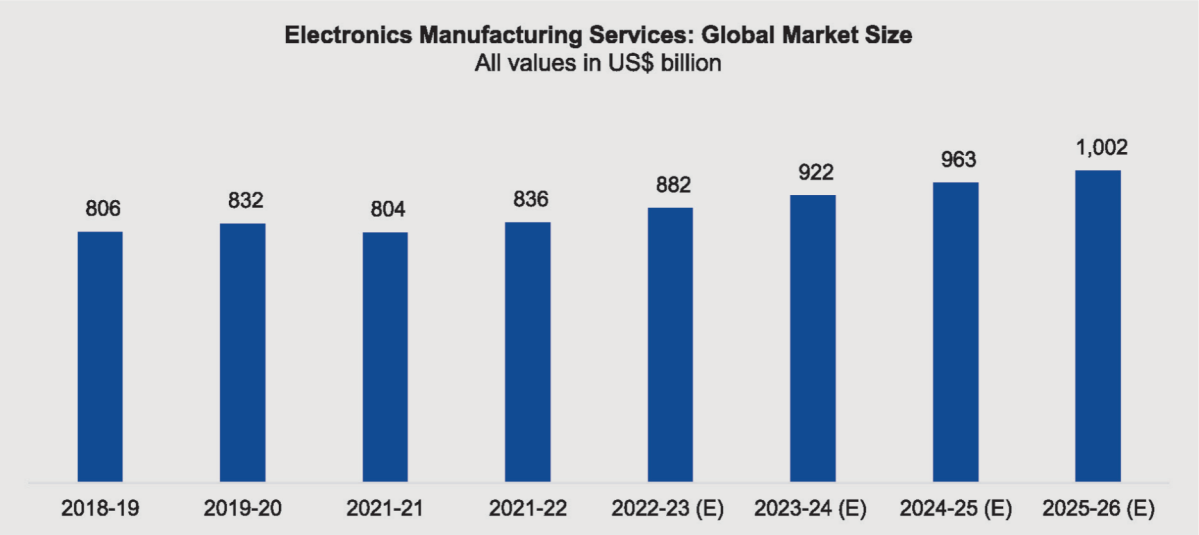



*Figure 42: Global EMS Industry Market Size[44] (FY 2018 to FY 2025)*

The Asia Pacific region provides the highest share to the Global EMS market with China as one of the most relevant markets. This is due to the ability of China to provide cost-effective manufacturing and having advanced manufacturing abilities. China also has highly skilled labour, proper infrastructure, and an established logistic network to supplement its manufacturing abilities.

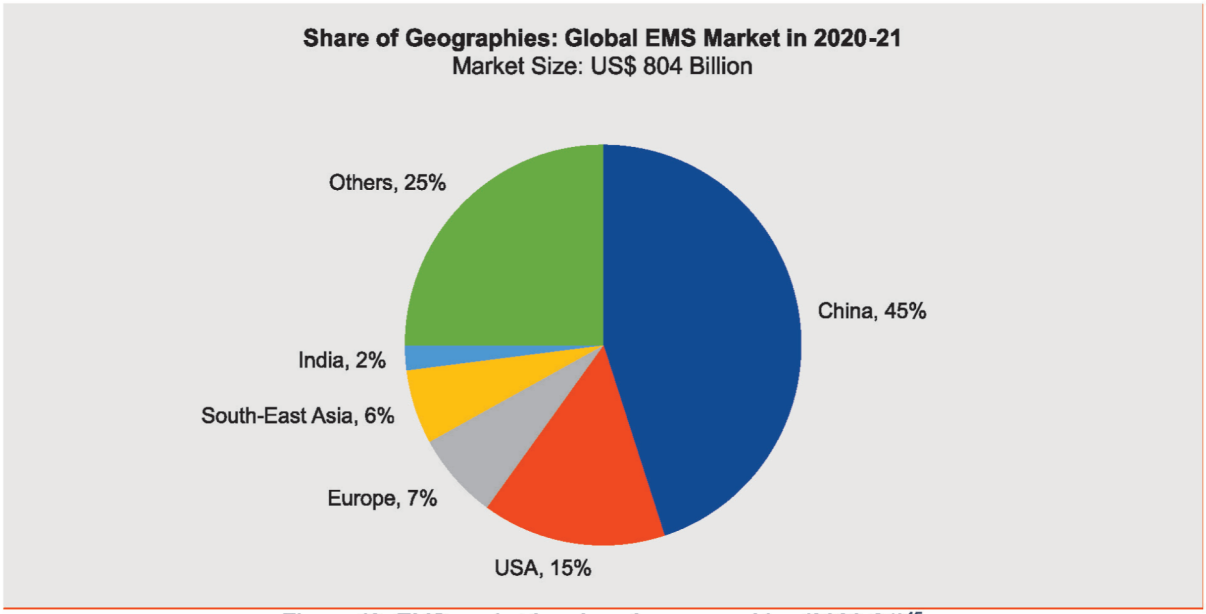



*Figure 43: EMS market break-up by geographies (2020-21)[45]*

However, post COVID-19, OEMs and major brands are looking to expand their supply chain to decrease dependence on China. This has opened doors for EMS companies in India to increase their global footprint.

Another global development which would have a positive impact for EMS industry in India is widening of services net of EMS companies globally. Thus, large EMS companies, many of whom are also present in India, and who were focussed on manufacturing and assembly part of the services spectrum are now moving up the value chain and planning to offer other services such as design as well as testing and sourcing of components.

[44] *https://www.bharatfih.com/wp-content/uploads/2021/12/Bharat-FIH_Indian-EMS-ODM-Industry-Report_Final_21-December-21.pdf*
[45] *https://www.bharatfih.com/wp-content/uploads/2021/12/Bharat-FIH_Indian-EMS-ODM-Industry-Report_Final_21-December-21.pdf*

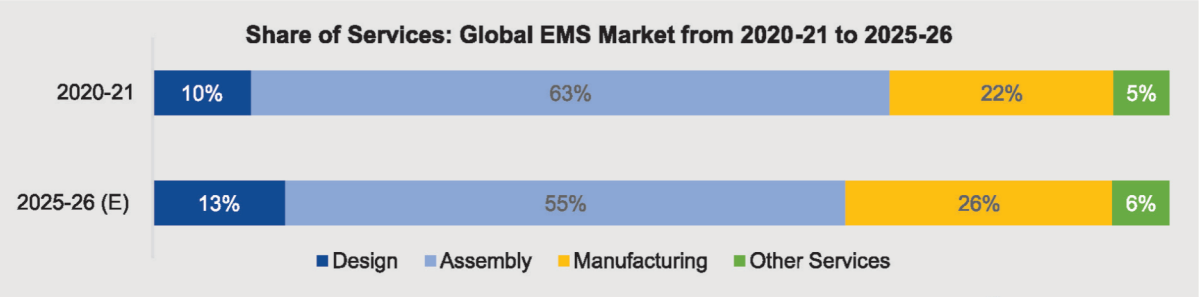



*Figure 44: Share of Services: Global EMS Market from 2020-21 to 2025-26[46]*

India has a strong design and research & development capabilities, especially in semi-conductors and components sub-sector, as seen in previous chapter, and, if this global movement from original equipment manufacturing (OEM) to original design manufacturing (ODM) gains traction, Indian EMS industry is also likely to benefit from the same.

## EMS industry: Indian scenario

Indian EMS industry, while almost three decades old, saw first big investment in India with the entry of Jabil Circuit and Nokia in the years 2005 to 2007. While by 2013-14, Nokia had wound up its operations, many global MNC companies have started investing in India since 2015. The current EMS industry in India mostly offers services such as component manufacturing & sourcing, manufacturing / assembling as well as logistics.

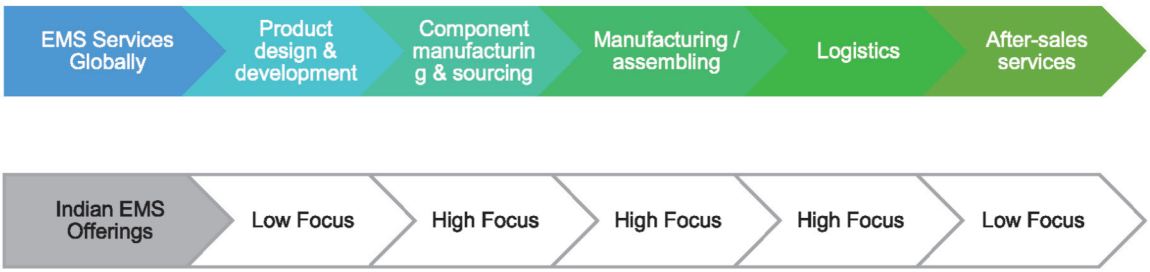



*Figure 45: Global EMS services versus Indian offerings*

Electronics Manufacturing Services (EMS) market in India was estimated to be around US$ 49 billion[47] in 2021-22. This comprises of around 60% of domestic manufacturing and remaining as PCBS/sub-assembly imports. Close to half of the EMS industry in India caters to mobile phones, followed by television, computer hardware as well as telecom and networking equipment which, all together, comprise of around 60% of the EMS industry in India. In fact, India is one of the top manufacturing hubs, as well as market, for mobile phones.

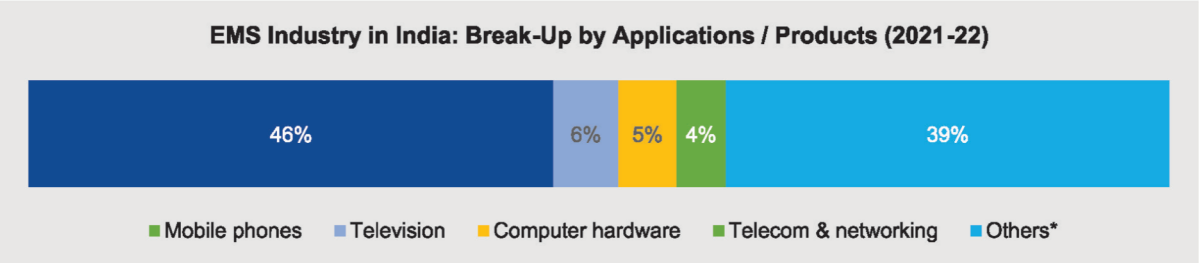



*Figure 46: EMS Industry in India: Break-Up by Applications / Products (2021-22)[48]*

[46] *https://www.bharatfih.com/wp-content/uploads/2021/12/Bharat-FIH_Indian-EMS-ODM-Industry-Report_Final_21-December-21.pdf*
[47] *https://elcina.com/ems-task-force-report-on-market-industry-analysis-of-ems-sector-in-india*
[48] *https://www.bharatfih.com/wp-content/uploads/2021/12/Bharat-FIH_Indian-EMS-ODM-Industry-Report_Final_21-December-21.pdf; * includes mechanics, electric vehicles, hearables, consumer electronics and appliances, automotive, industrial applications, lighting etc.*

There are three broad EMS components in India, viz. EMS by OEMs (made in India) as well as EMS by Indian firms and EMS activity imports.

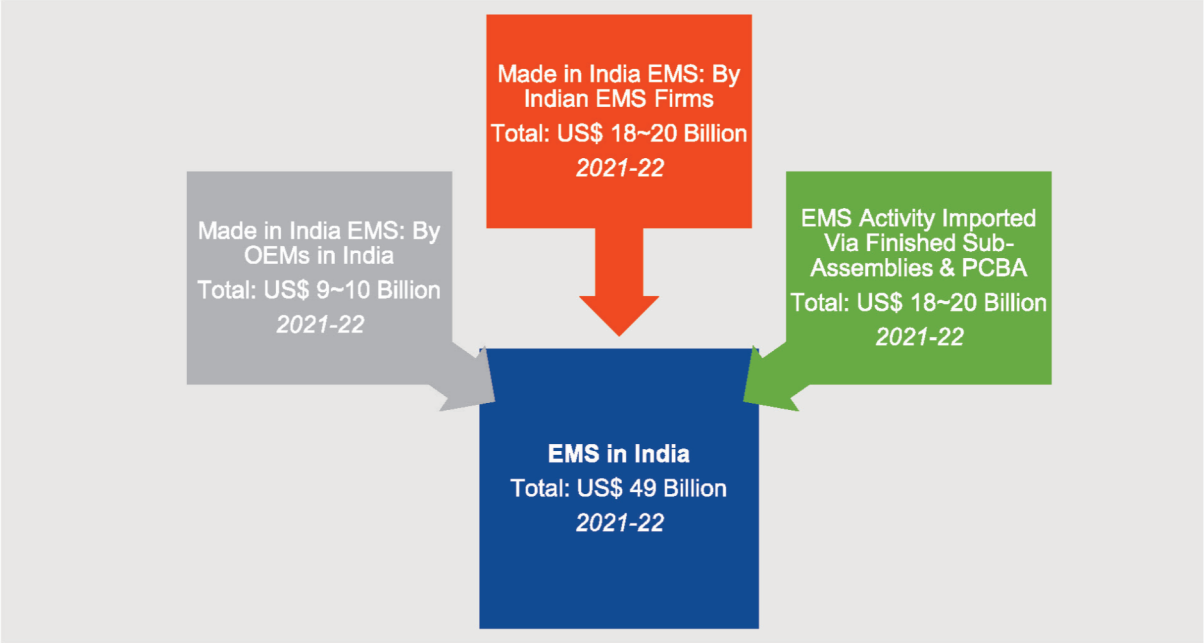



*Figure 47: EMS composition in India*

Indian OEMs that manufacture in-house include[49] Samsung, Vivo, Oppo etc. Major EMS companies include[50] Foxconn (manufacturing for Xiaomi, Nokia etc.), HiPad (manufacturing for RealMe, Xiaomi, etc), Flex etc.

In addition, there are at least around 100 major EMS companies, both MNC and Indian, currently operating in India[51] out of which major ones include[52] Jabil Circuit, Dixon Technologies, SFO Technologies, Elin Electronics, Rangsons Electronics, Kaynes Technology, Centum Electronics, SGS Tekniks, etc. In addition, there are more than 500 small and mid-sized EMS companies present in India.

| Indian OEMs | MNC EMS Companies | Large Indian EMS Companies | Small & Medium Indian EMS Companies |
|---|---|---|---|
| • Examples include: Samsung, Vivo, Oppo etc. | • Examples include: Foxconn (manufacuturing for Xiaomi, Nokia etc.), Bharat FIH, Cyient DLM, Flex, Jabil Circuit, Pegatron, Sanmina, Wistron etc. | • Examples include Amber Enterprises, Centum Electronics, Dixon Technologies, Elin Electronics, SFO Technologies, Syrma SGS Technology etc. | • Numerous companies are present but some major examples include Avalon Technologies, Kaynes Technologies, PG Electroplast, Rangsons Electronics, VVDN Technologies etc. |

*Figure 48: Major EMS companies in India*

[49] *https://telecom.economictimes.indiatimes.com/news/xiaomi-nokia-help-foxconn-become-leading-ems-player-in-india-in-2018-counterpoint/69872512*
[50] *https://telecom.economictimes.indiatimes.com/news/xiaomi-nokia-help-foxconn-become-leading-ems-player-in-india-in-2018-counterpoint/69872512*
[51] *https://www.essc-india.org/wp-content/uploads/Feedback_ESSCI_Book_V4_10092019.pdf, Kantar analysis*
[52] *https://www.electronicsb2b.com/eb-specials/leading-organisations/top-10-ems-companies-india-2/*

Indian EMS industry is expected[53] to grow at a CAGR of around 45%. As per these estimates, it is expected to cross US$ 215 billion by 2025-26.

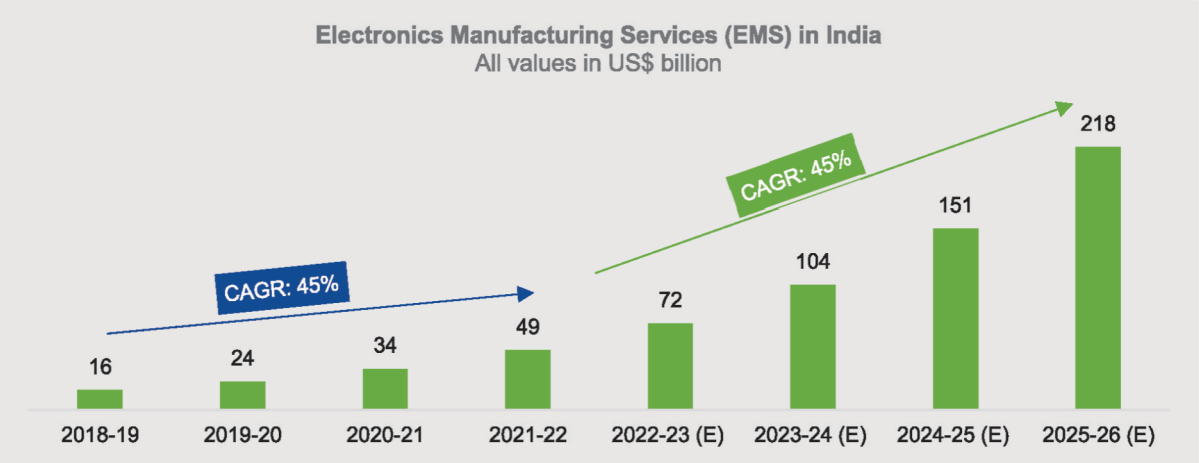



*Figure 49: Electronics Manufacturing Services (EMS) market in India (FY 2018 to FY 25)*

There are multiple factors which would continue driving the growth of EMS industry in India. These are discussed below:


*Figure 50: Drivers for growth in EMS industry in India*

1. **China+1 strategy:** Multiple factors such as rising cost structure of EMS sector in China, geo-political landscape, including US-China trade war, disruptions caused by Covid-19 etc. have had two-fold impacts. First, it has spurred major global OEMs to look for EMS partners in geographies other than China. These geographies include countries such as India, Vietnam, Indonesia as well as other South-East Asian countries. Secondly, many global EMS companies are also now looking at India to set-up their operations. However, considering overall cost & efficiency related advantages in China, due to sub-tier vendor ecosystem, China is unlikely to be fully replaced as an EMS hub. Many global firms as well as Indian companies/groups have sensed this movement and are bullish in their Indian plans. Some examples include the following:
    a. Flex, a manufacturer of electronic components based in the United States, is considering increasing its investment in India to around US$ 12 billion to expand its manufacturing capabilities and boost exports from India[54].

[53] *https://elcina.com/ems-task-force-report-on-market-industry-analysis-of-ems-sector-in-india*
[54] *https://economictimes.indiatimes.com/industry/cons-products/electronics/flex-may-shift-from-china-and-invest-500-million-in-india/articleshow/71884141.cms*

b. In 2021, TATA Electronics (TATA Group) stated that it will invest INR 57 billion (US$ 790 million) as part of its phase 1 investment in an industrial complex in Tamil Nadu, India, to construct a phone component manufacturing facility[55].
c. In 2021, Jabil announced they are going to invest INR 20 billion (US$ 275 million) in Pune and plans to venture into smartphones, home appliances, mobile spare parts, and food packaging[56].
d. Dixon Technologies, a provider of electronic manufacturing services, announced in 2021 that it would invest approximately INR 6 billion (US$ 80 million) to build new capacity in India in the mobile devices, laptops and tablets, telecom equipment, and LED components segments to serve the domestic and global markets[57].

2. **OEM to ODM:** India has, traditionally, been a 'design' hub for major semiconductor and electronics companies with major global players having their design centres in India. Historically, the IP rights were owned by global headquarters of major global OEMs who engaged Indian EMS companies for contract manufacturing only. However, gradually, the ODM model is gaining traction in India where OEMs are now partnering with their EMS partners, generally the MNC or large Indian ones, on product development too. As the ODM model grows stronger, the EMS sector in India will witness a sharp growth due to opening up of additional revenue streams and opportunities.

3. **Rising consumer demand:** Consumer demand for electronics products in India such as mobile phones, computers (desktops/laptops), consumer durables etc. have been consistently increasing in India due to multiple factors such as rise in disposable incomes, faster replacement cycles for products as well as, more recently, Covid-19 pandemic which gave rise to work-from-home culture leading to accelerated demand for computer and networking products. These factors are likely to continue in future and would, in turn, give a boost to EMS sector in India to fulfil these demands.

4. **Favourable government policies[58]:** Various government schemes such as Production Linked Incentive (PLI) scheme for large scale electronics manufacturing as well as for IT hardware and Modified Electronics Manufacturing Clusters Scheme (EMC 2.0) are likely to give a boost to EMS sector in India. These schemes are explained below:

   a. **PLI scheme for large scale electronics manufacturing** provides financial boost to spur domestic manufacturing of products such as SMT components, printed circuit boards (PCB), PCB laminates, prepregs, photopolymer films, PCB printing inks, sensors, transducers, actuators, crystals for electronic applications, system in package (SIP), micro / nano-electronic components such as micro electromechanical systems (MEMS) and nano electromechanical systems (NEMS) etc. In this scheme, production linked incentives of more than INR 40,000 crores would be awarded over a period of 4 years from 2021.

   b. Similarly, **PLI scheme for IT hardware** proposes to award incentives worth INR 7,300 crores over 4 years from 2021 for products such as laptops, tablets, all-in-one PCs and servers.

   c. The **modified Electronics Manufacturing Clusters scheme (EMC 2.0)** aims to strengthen infrastructure for electronics industry in India and would include development of facilities like Common Facility Centres, Ready Built Factory, Sheds/Plug and Play facilities etc. Financial incentives worth INR 3,762 crores would be disbursed over a period of 8 years.

[55] *https://www.livemint.com/companies/news/tata-group-to-set-up-rs-5000-crore-phone-component-making-unit-in-tn-report-11603867877879.html*
[56] *https://www.thehindubusinessline.com/companies/jabil-to-invest-2000-cr-in-pune/article34850948.ece*
[57] *https://www.business-standard.com/article/companies/dixon-invests-rs-600-crore-to-build-new-facility-under-pli-scheme-121050701442_1.html*
[58] *https://www.investindia.gov.in/schemes-for-electronics-manufacturing*

## Manpower requirement

EMS sector in India employs around 12 Lacs people currently[59]. This comprises of both permanent and contractual employees – in fact, a higher proportion of employees in this sector is contractual in nature. During the period 2016 to 2022, this employee base has grown at a rapid rate (CAGR) of more than 50%. It is expected that the manpower would continue growing at the same rate – i.e., around 50% - for at least next 4-5 years. Therefore, it is estimated that this sector would employ more than 6 million people by the end of 2025-26.

**Kantar interviewed some of the major EMS companies in India to understand their view regarding future manpower requirement in India. There was a near unanimous view that the current high growth rate of around 50% would continue for at least the next few years.**

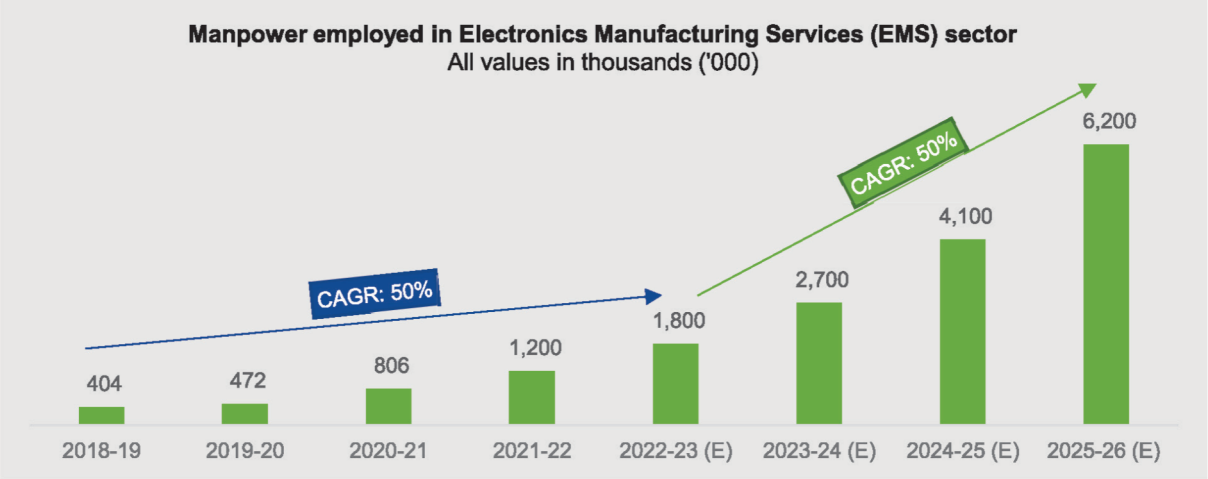



*Figure 51: Manpower employed in EMS sector in India (FY 2018 to FY 2025)*

Future estimates of manpower have been derived basis two methods as shown below:

**Historic Growth Rate**

Historic growth rate of manpower in EMS sector is around 50%.

**Expected Growth Rate**

As per industry experts, manpower intake in the next few years in EMS sector would be at least 50% and can even cross 55-60%. Some experts even consider a 100% growth rate in manpower year-on-year is not impossible.

59 https://www.essc-india.org/wp-content/uploads/Feedback_ESSCI_Book_V4_10092019.pdf

A bulk of manpower, around 50%, is employed in manufacturing, assembly & testing roles and the rest in design, R&D, quality assurance/control roles as well as other service roles such as after-sales services.

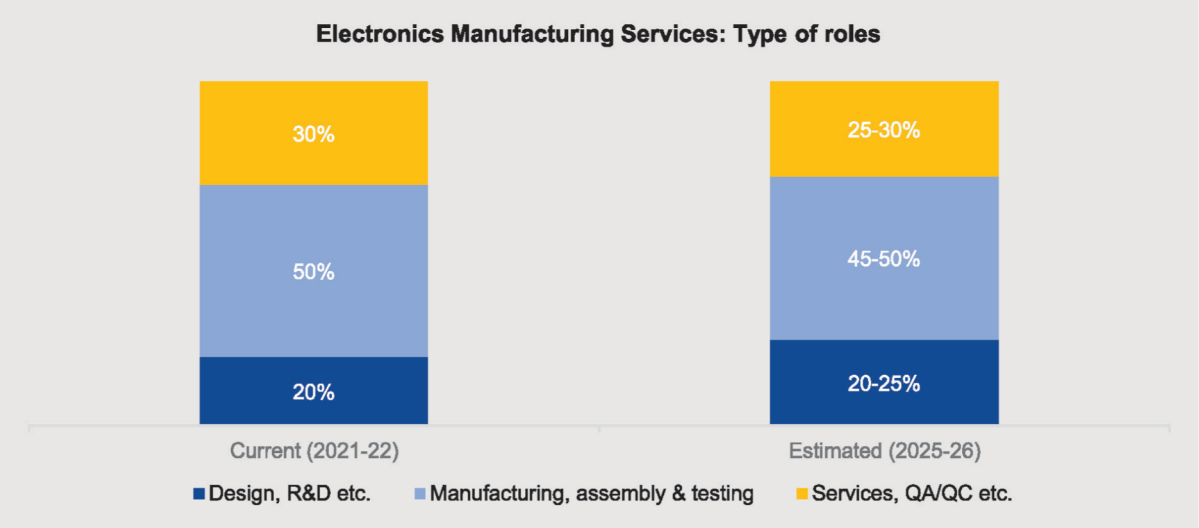
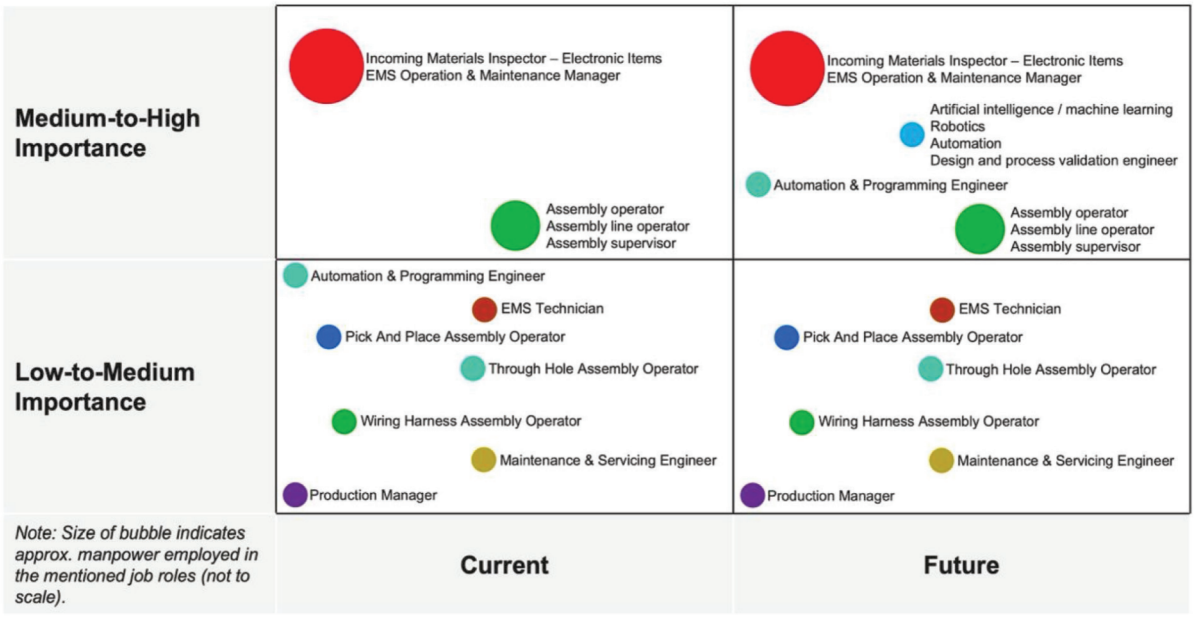



*Figure 52: Manpower in Electronics Manufacturing Services (EMS): Type of roles*[60]

However, as industry moves from OEM to ODM model, the design & R&D roles are likely to increase somewhat. However, even by the next 4~5 years, the bulk of the roles would remain in the manufacturing, assembly and testing domains.




Jobs related to quality control and assembly line operations are the ones which employ most people in EMS sector.

These are also the ones which are medium to high in importance. In fact, their importance is only likely to grow in future. Other jobs which would emerge in future would be:

- Artificial intelligence / machine learning
- Robotics
- Automation
- Design and process validation engineer

[60] *Source: Kantar primary survey.*

# Major job roles, required skills and upskilling practices

## Major job roles

Major job roles in EMS sector are in manufacturing, assembly & testing domains as well as in services (including QA/QC domain). These are listed below[61]:

*Figure 53: Job roles relevant for Electronics Manufacturing Services (EMS) sector[62]*

| Design, R&D Etc. | Manufacturing, Assembly & Testing | Services, QA/QC Etc. |
|---|---|---|
| — Automation & Programming Engineer | — Assembly Line Operator<br>— Assembly Operator<br>— Assembly Supervisor<br>— EMS Operation & Maintenance Manager<br>— EMS Technician<br>— Pick And Place Assembly Operator<br>— Through Hole Assembly Operator<br>— Wiring Harness Assembly Operator<br>— Maintenance & Servicing Engineer<br>— Production Manager | — In-process and Final Quality Engineer (PCB)<br>— Incoming Materials Inspector-Electronics Items<br>— Incoming QC Technician (PCB) |

Top job roles which are critical for smooth functioning of core operations in an EMS company are listed below along with their minimum requirements (in terms of education and experience). The table also shows the expected future trajectory – i.e., their importance or criticality in future.

*Figure 54: Top job roles critical in Electronics Manufacturing Services (EMS) sector*

| **Top Job Roles** *(In Order of Importance)* | **Function** | **Minimum Requirements Necessary** *(Education and Experience)* | **Expected Future Trajectory/Importance** |
|---|---|---|---|
| Incoming Materials Inspector – Electronic Items | Services | **Education:** Graduation (Technical); For e.g., B.E., B.Tech.<br>**Experience:** Between 3 to 10 years. | Highly likely to increase in importance. |
| EMS Operation & Maintenance Manager | Manufacturing | **Education:** Graduation (Technical); For e.g., B.E., B.Tech.<br>**Experience:** Fresher to up to 5 years. | Highly likely to increase in importance. |
| Assembly Operator | Manufacturing | **Education:** Graduation (Technical); For e.g., B.E., B.Tech.; Preferred Post-Graduation (Technical) For e.g., M.E., M.Tech.<br>**Experience:** Ideally 3+ years; but more than 1 year is accepted. | Would either remain same in importance or grow in importance. |

[61] *Source: ESSCI*
[62] *Source: ESSCI*

| **Top Job Roles** *(In Order of Importance)* | **Function** | **Minimum Requirements Necessary** *(Education and Experience)* | **Expected Future Trajectory/Importance** |
|---|---|---|---|
| EMS Technician | Manufacturing | **Education:** Graduation (Technical); For e.g., B.E., B.Tech. **Experience:** No minimum experience | Would either remain same in importance or grow in importance. |
| Assembly Line Operator | Manufacturing | **Education:** Any graduation (technical or non-technical) **Experience:** 1 to 5 years. | Likely to remain same in importance. |
| Assembly Supervisor | Manufacturing | **Education:** Minimum: Diploma either after class X or Class XII with relevant experience. Preferred: B.E./B.Tech. in Electrical / Electronics / Mechanical Engineering. **Experience:** 1 to 3 years of experience. | Likely to remain same in importance. |
| In-process and Final Quality Engineer (PCB) | Services | **Education:** Minimum: Diploma either after class X or Class XII with relevant experience. Preferred: B.E./B.Tech. in Electrical / Electronics / Mechanical Engineering. **Experience:** 1 to 3 years of experience. | Likely to remain same in importance. |
| Incoming QC Technician (PCB) | Services | **Education:** Minimum: Diploma either after class X or Class XII with relevant experience. Preferred: B.E./B.Tech. in Electrical / Electronics / Mechanical Engineering. **Experience:** 1 to 3 years of experience. | Likely to remain same in importance. |
| Pick And Place Assembly Operator | Manufacturing | **Education:** Minimum class 8$^{th}$ with ITI and relevant experience. **Experience:** Minimum 2 years of experience. | Likely to remain same in importance. |
| Through Hole Assembly Operator | Manufacturing | **Education:** Minimum class 8$^{th}$ with ITI and relevant experience. **Experience:** Minimum 2 years of experience. | Likely to remain same in importance. |
| Wiring Harness Assembly Operator | Manufacturing | **Education:** Diploma either after class X or Class XII with relevant experience. **Experience:** 1 to 3 years of experience. | Likely to remain same in importance. |

While shop-floor jobs in a company such as EMS Technician or Assembly Line Operator may even contribute to around 25-30% of manpower in a company, those related to services such as quality etc., may be not more than 10% of the job roles in the company.

A sample occupational map of some of the key job roles above is given below:

*Figure 55: Sample occupational map for a few illustrative job roles in EMS sector*

| Job Role | Assembly Line Operator | In-process and Final Quality Engineer (PCB) |
|---|---|---|
| **Category** | Manufacturing, Assembly & Testing | Services, QA/QC Etc. |
| **Education** | Any graduation (technical or non-technical). | Minimum: Diploma either after class X or Class XII with relevant experience. Preferred: B.E./B.Tech. in Electrical / Electronics / Mechanical Engineering. |
| **Experience** | Between 1 to 5 years. | Between 1 to 3 years. |
| **Skills** | Automation testing, programming languages such as Java, JavaScript, etc. and object-oriented programming. | Electronics engineering, quality management, electronics components, quality control, quality audit, QC inspection, supplier quality, PCB, CAPA, SMT Process, MATLAB, LTSpice, PSpice, SMPS, Hardware Modelling |

Future job roles may include in fields such as:

- Artificial intelligence / machine learning
- Robotics
- Automation
- Design and process validation engineer

## Critical skills: Technical

Some of the key skills required for major job roles in this sector are listed below:

*Figure 56: Top skills required for major job roles in EMS sector.*

| Job Category | Job Roles | Key skills[63] |
|---|---|---|
| **Design, R&D Etc.** | Automation & Programming Engineer | Good understanding of CMOS and/or DRAM / NAND / NOR memory reliability failure modes. |
| **Manufacturing, Assembly & Testing** | Assembly Line Operator | Automation testing, programming languages such as Java, JavaScript, etc. and object-oriented programming. |
| | Assembly Supervisor | Lean Manufacturing, Six Sigma, 8D tool, Process audit, Quality Systems, Quality Standards, QS 900. |
| | EMS Operation & Maintenance Manager | Centum Adeneo, plant maintenance |
| | EMS Technician | Production, testing |
| | Pick And Place Assembly Operator | Machine Operator, OEE control, Knowledge of CPH, MTTR, MTBF, equipment engineering, SMT Process, SMD, mechanical maintenance etc. |
| | Wiring Harness Assembly Operator | IPC A 610 & IPC WHMA 620. |

[63] *Sources: LinkedIN, Naukri.com, Kantar primary research.*

| | | |
|---|---|---|
| | Maintenance & Servicing Engineer | Orcad, Altium, embedded processors, hardware design, hardware development, signal integrity analysis. |
| | Production Manager | PCB Assembly, wave soldering, SMT process, servo motor. |
| **Services, QA/QC Etc.** | In-process and Final Quality Engineer (PCB)<br>Incoming QC Technician (PCB) | PCB designing, design engineering<br><br>Electronics engineering, quality management, electronics components, quality control, quality audit, QC inspection, supplier quality, PCB, CAPA, SMT Process, MATLAB, LTSpice, Pspice, SMPS, Hardware Modelling |

Apart from the above specific job-role wise skills, in view of employees, top five general technical skills considered critical in Electronics Manufacturing Services (EMS) sector are knowledge of computer hardware/software as well awareness of electronics/electrical concepts. These are followed by knowledge on circuit design, quality systems, systems analysis, testing etc.

*Figure 57: Top technical skills critical for EMS sector*

| Rank | Technical Skills *(Ranked in terms of number of personnel with skill required)* | Relevance *(For Job Security)* | Relevance *(For Job Promotions)* | Current Readiness |
|---|---|---|---|---|
| 1 | Technical knowledge: Computer hardware & software | Medium | Medium | High |
| 2 | Technical knowledge: Electronics & electrical systems | High | High | Medium |
| 3 | Circuit design | Medium | Medium | Medium |
| 4 | Quality control / assurance | Medium | Medium | High |
| 5 | Systems analysis | High | High | Medium |
| 6 | Testing | Medium | Low | Medium |

Technical knowledge of electronics and electrical systems and systems analysis are both considered highly relevant skills for job security and job promotions. However, the current readiness on both these skill sets is not very high and can be said to be medium in level. On the other hand, while quality control/assurance and technical knowledge of computer hardware and software are considered of medium relevance for job security as well as job promotions, the current readiness level of employees working in this sector on these skills is high. Circuit design and testing are generally medium in relevance for job security but are medium in level on current readiness.

## Critical skills: Non-technical

Top non-technical skills required for major job roles in EMS sub-sector in India include communications skills, project management and/or production management, leadership & team management, and problem identification & solving.

| Rank | Non-Technical Skills *(Ranked in terms of number of personnel with skill required)* | Relevance *(For Job Security)* | Relevance *(For Job Promotions)* |
|---|---|---|---|
| 1 | Communication skills | High | High |
| 2 | Project management and/or production management | High | High |

| Rank | Non-Technical Skills *(Ranked in terms of number of personnel with skill required)* | Relevance *(For Job Security)* | Relevance *(For Job Promotions)* |
|---|---|---|---|
| 3 | Leadership and team management | Medium | Medium |
| 4 | Problem identification & solving | Medium | Medium |

Communications skills as well as project/production management skills are considered highly relevant both from the perspective of job security as well as for promotions in job. On the other hand, leadership and/or team management and problem identification & solving are considered medium in relevance for job security as well as promotions.

## Training practices: Internal and/or external

Only around 30% EMS companies feel that their newly hired employees are fully job-ready who require no training. Almost half feel that while they are somewhat ready but do require some training.

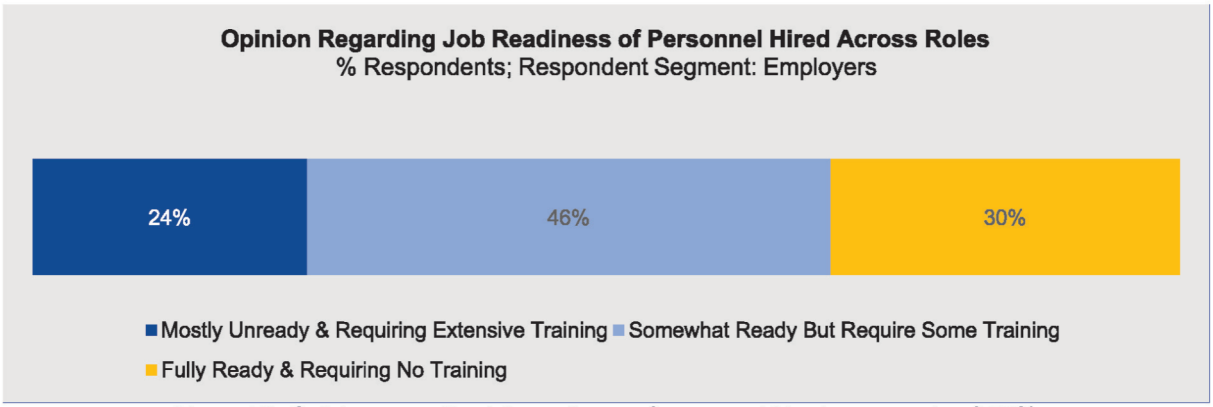



*Figure 58: Opinion regarding job readiness of personnel hired across roles (EMS)*

Most EMS companies provide on-job training to their employees to gain skills which are necessary for being job-ready. More than half the companies also provide orientation training upon joining while just around a quarter also consider other industry/lab visits.

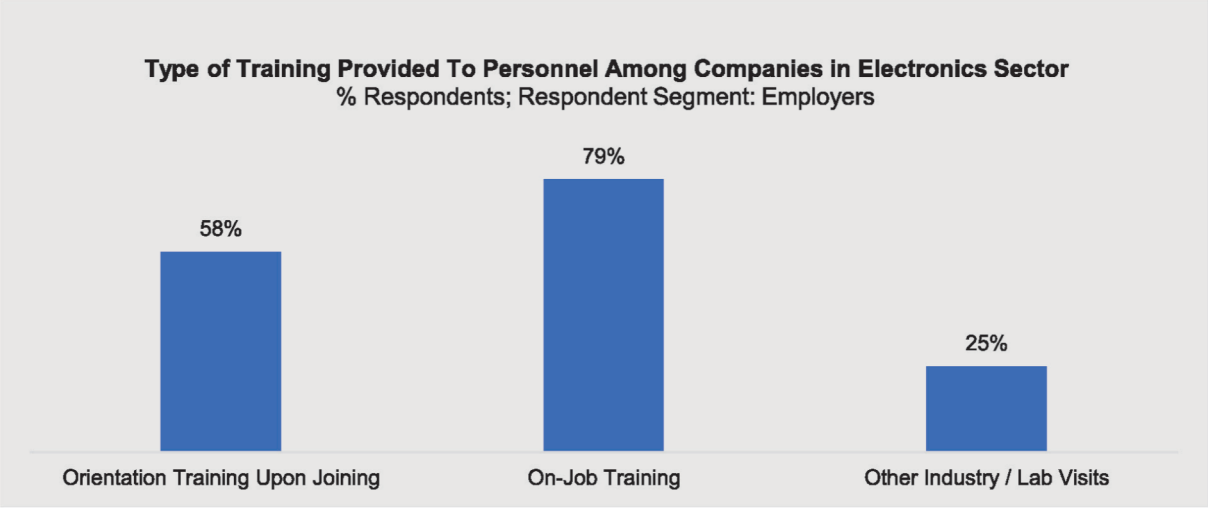



*Figure 59: Type of training provided to personnel by companies in electronics sector (EMS)*

Just around 50% of EMS companies provide orientation training which is less than one month in duration. However, an almost equal number of EMS companies also provide such training for a duration spanning a quarter of a year.

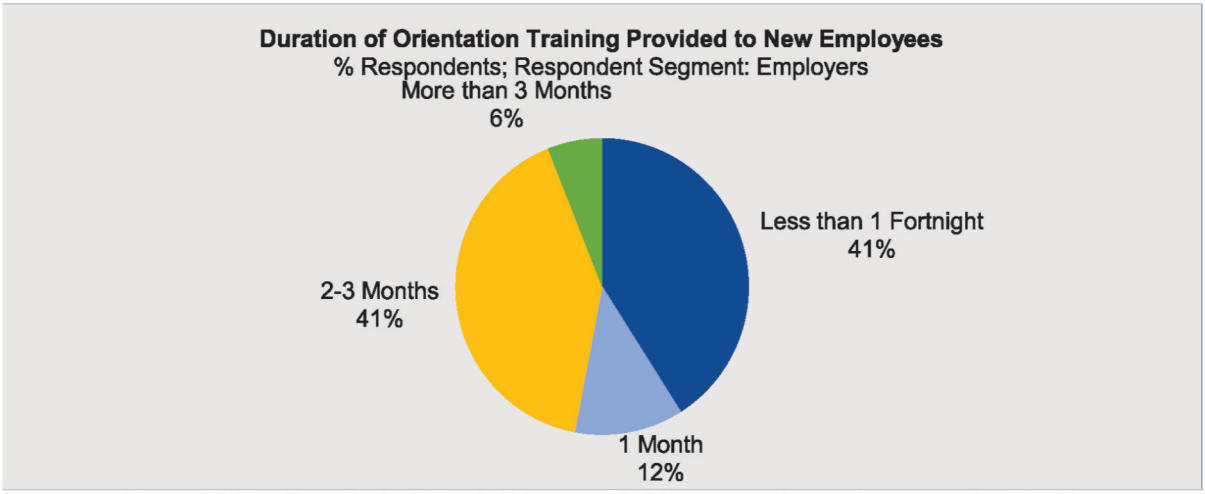



*Figure 60: Duration of orientation training provided to new employees by companies (EMS)*

There are over 375 training institutes, across India, which have partnered with ESSCI to provide training to personnel for becoming job ready in electronics sector. Top-5 courses (in terms of absolute enrolment), in EMS segment, for which these training institutes provide training include Electronic Hardware Design Engineer, Assembly Supervisor, EMS Operation and Maintenance Manager, Mechanical Fitter, PPC Engineer etc.

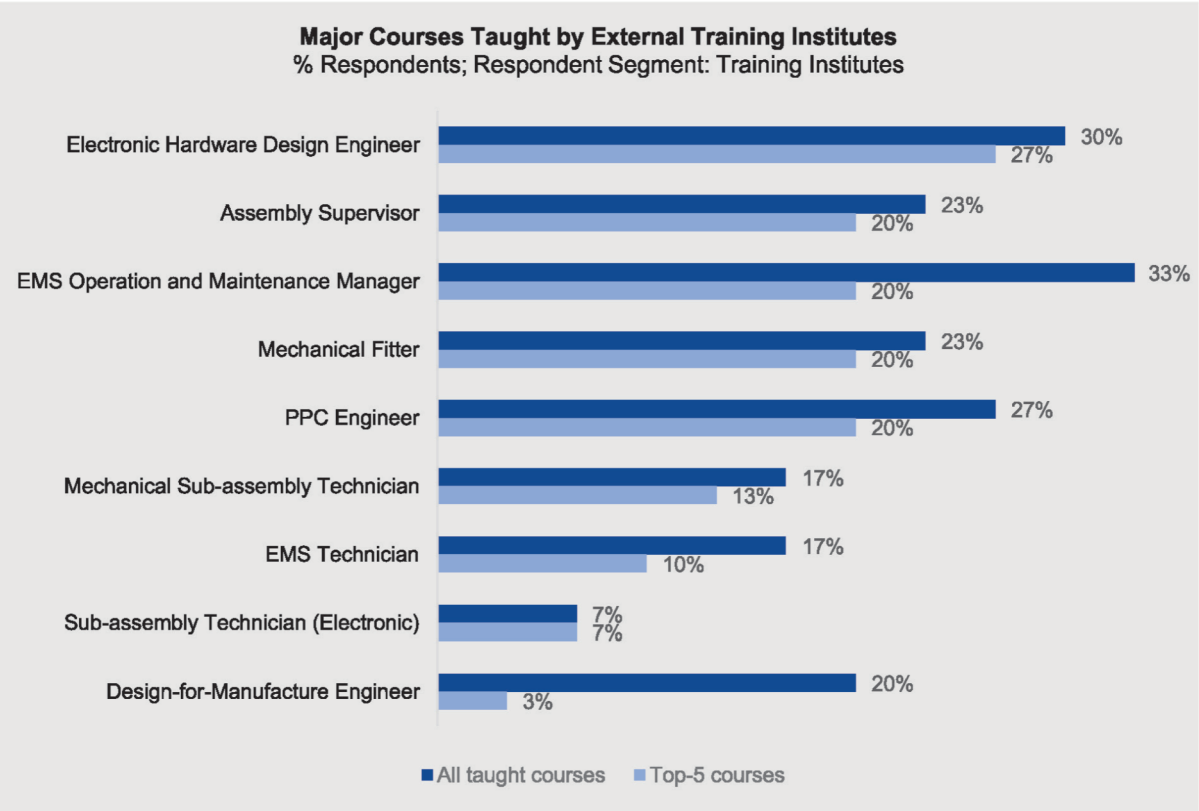



*Figure 61: Major courses (for job roles) taught by ESSCI approved training institutes (EMS)*

In view of external training institutes, EMS job roles which hold top importance are Design-for-Manufacture Engineer, Sub-assembly Technician and PPC Engineer. Not only are these job roles high in demand among trainees, as shown by enrolment levels to the training courses, but are also deemed highly relevant for job prospects, security and promotion by these training institutes.

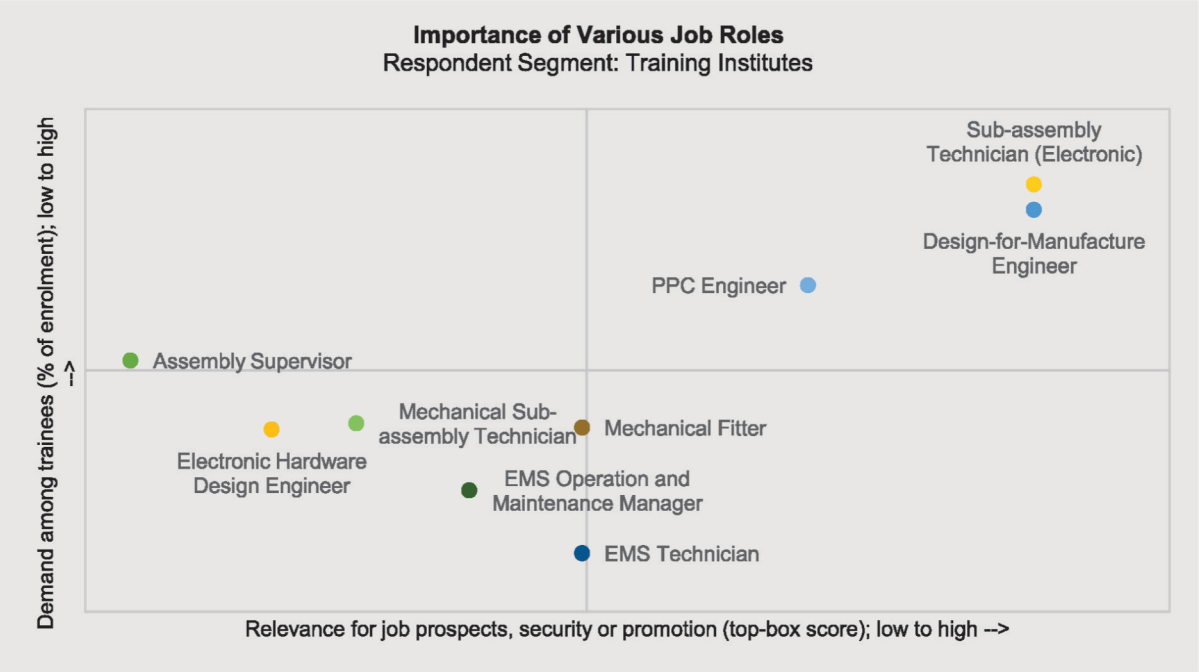



*Figure 62: Importance of various job roles (EMS)*

In view of these training institutes, the top reason for low demand, among students/trainees, for some of these courses is the high cost of training followed by low demand from the industry itself.

The two key challenges which training institutes face in providing training in EMS sub-sector are quality and availability of instructors as well as demand for courses/programs among students.

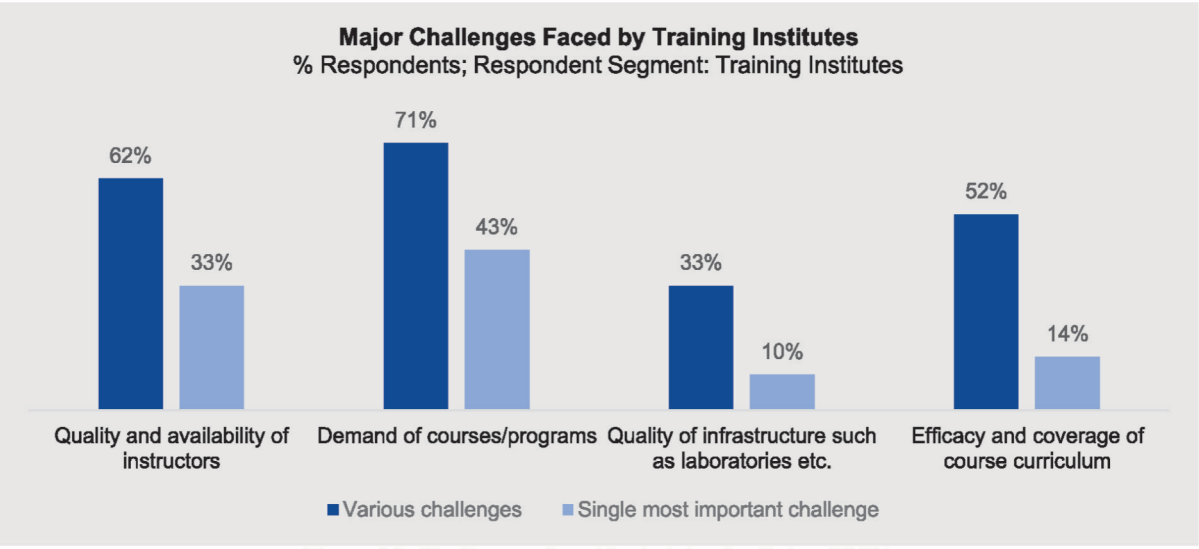



*Figure 63: Challenges faced by training institutes (EMS)*

While considering their experience with external institutes/facilities for skill development for their industry, industry leaders in the EMS sector are, generally, satisfied with relevance of the curriculum for industry requirements, efficacy of training provided (leading to job readiness of the trainees) as well as their level of collaboration with the industry to stay up to date on new technological developments. However, the key pain point is the cost of training provided at these institutes/facilities. They are also not very satisfied with the number of training institutes available to satisfy the demands as well as quality of instructors/trainers employed by them.


*Figure 64: Level of satisfaction with external training institutes (EMS)*

## Upskilling practices by employees

Employees in various companies operating in electronics manufacturing sector actively strive to keep themselves upskilled in order to remain relevant in the ever-changing job market. However, they face multiple challenges to remain upskilled. The most common challenges faced by them are the lack of time and a lack of funds. Many of them also feel that there is a lack of availability of training resources – whether within organization or outside it.

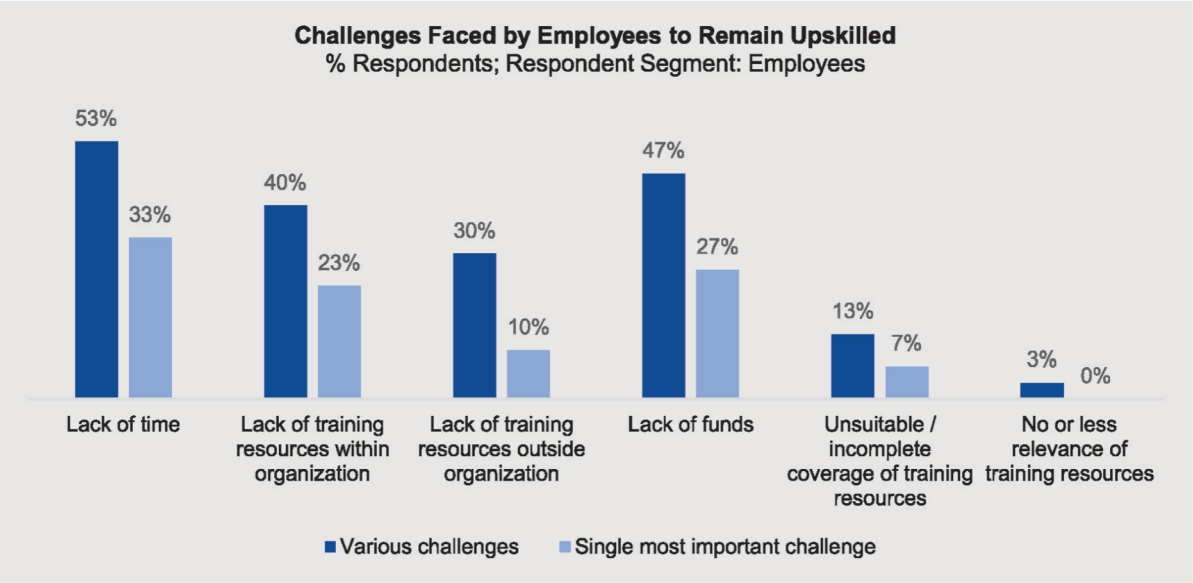



*Figure 65: Challenges faced by employees to remain upskilled (EMS)*

The largest mode of training received by employees in their company is on-job training followed by training company training portal (or other online training courses funded by the company).

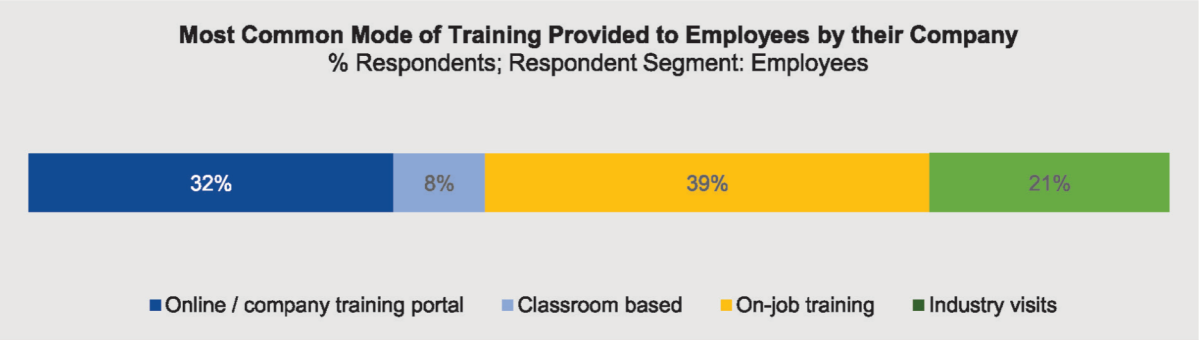



*Figure 66: Common modes of training provided to employees by companies (EMS)*

Most employees not only find the coverage of course curriculum, of in-house training, adequate but also relevant for increasing their efficiency and efficacy in their jobs.

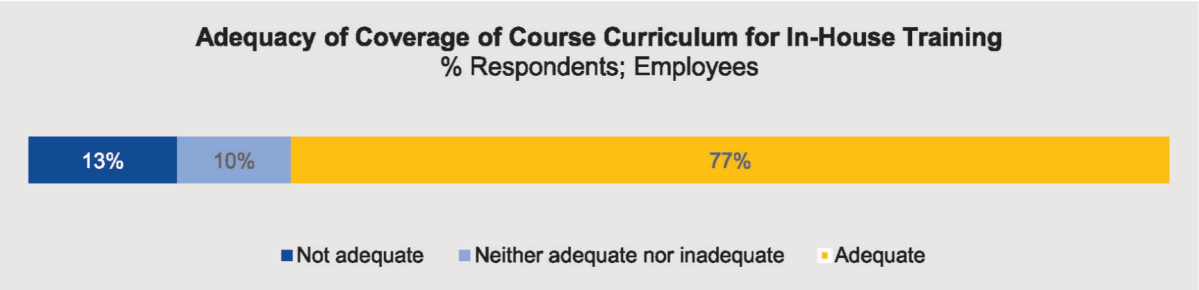



*Figure 67: Adequacy of coverage of course curriculum for in-house training (EMS)*

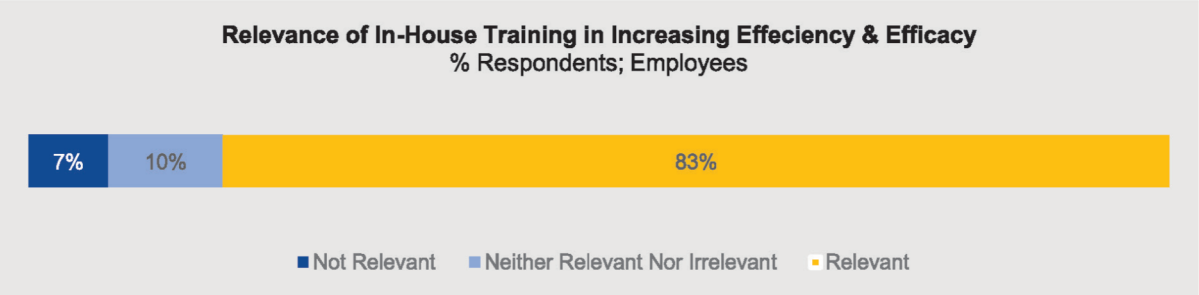



*Figure 68: Relevance of in-house training in increasing efficiency & efficacy of employees (EMS)*

Apart from being trained by their company, many of these employees also use external sources of training – most commonly being online/MOOC courses available on Coursera, Unacademy, eDX etc. – to remain upskilled. Many of them also taken for industry visits by their companies (or, rarely, on self-initiative).

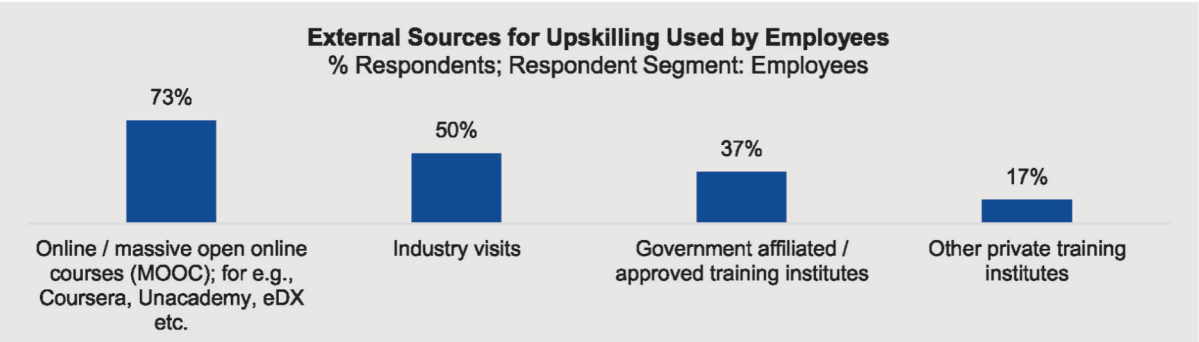



*Figure 69:External sources of training used by employees for upskilling (EMS)*

Industry visits, followed by government approved training institutes, are generally considered the best in terms of their coverage of training material. Interestingly, while online/MOOC courses are preferred by a large percentage of employees, very few find the coverage there as excellent.

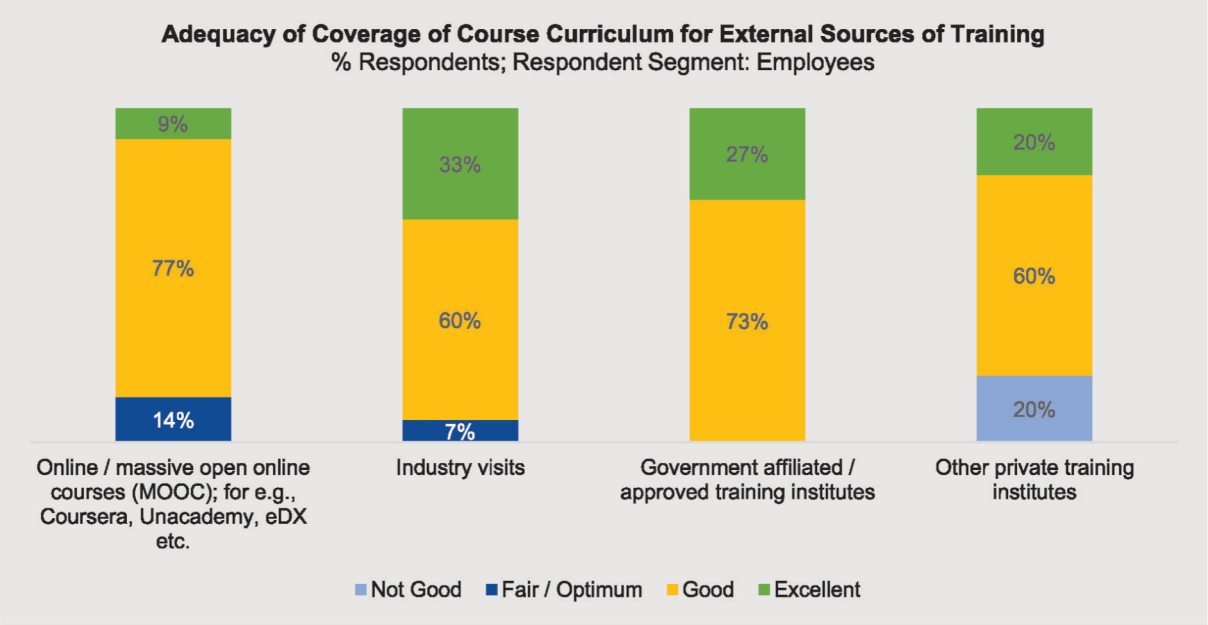



*Figure 70: Adequacy of coverage of course curriculum for external training (EMS)*

Training and experience provided by industry visits are also considered among the best for increasing efficiency and efficacy of their jobs.

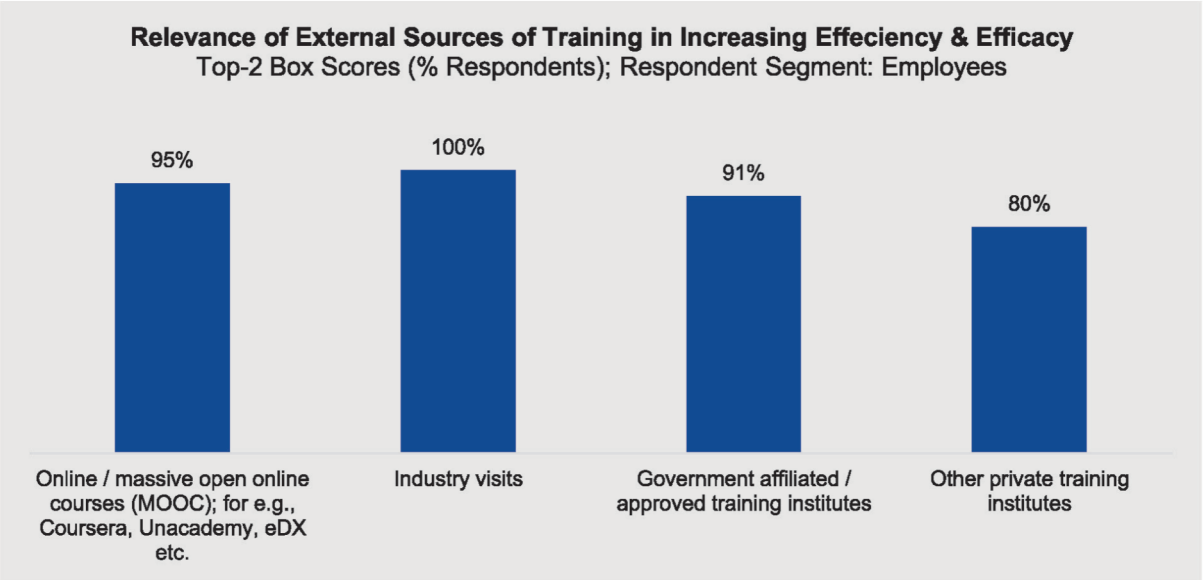



*Figure 71: Relevance of external training in increasing efficiency & efficacy of employees (EMS)*

# Hearables & wearables

## Introduction

Hearable devices are defined as comprising of any audio device that is worn on the person of the user – generally in the ear. These, therefore, include earphones, headphones, audio earbuds etc. but do not include speakers. Wearables are defined as comprising of products such as smart wrist watches, fitness tracker bands and similar wrist wearable devices. The hearables market segments can be classified based on several criteria like[64] type of products, physical usage, technology used, etc.

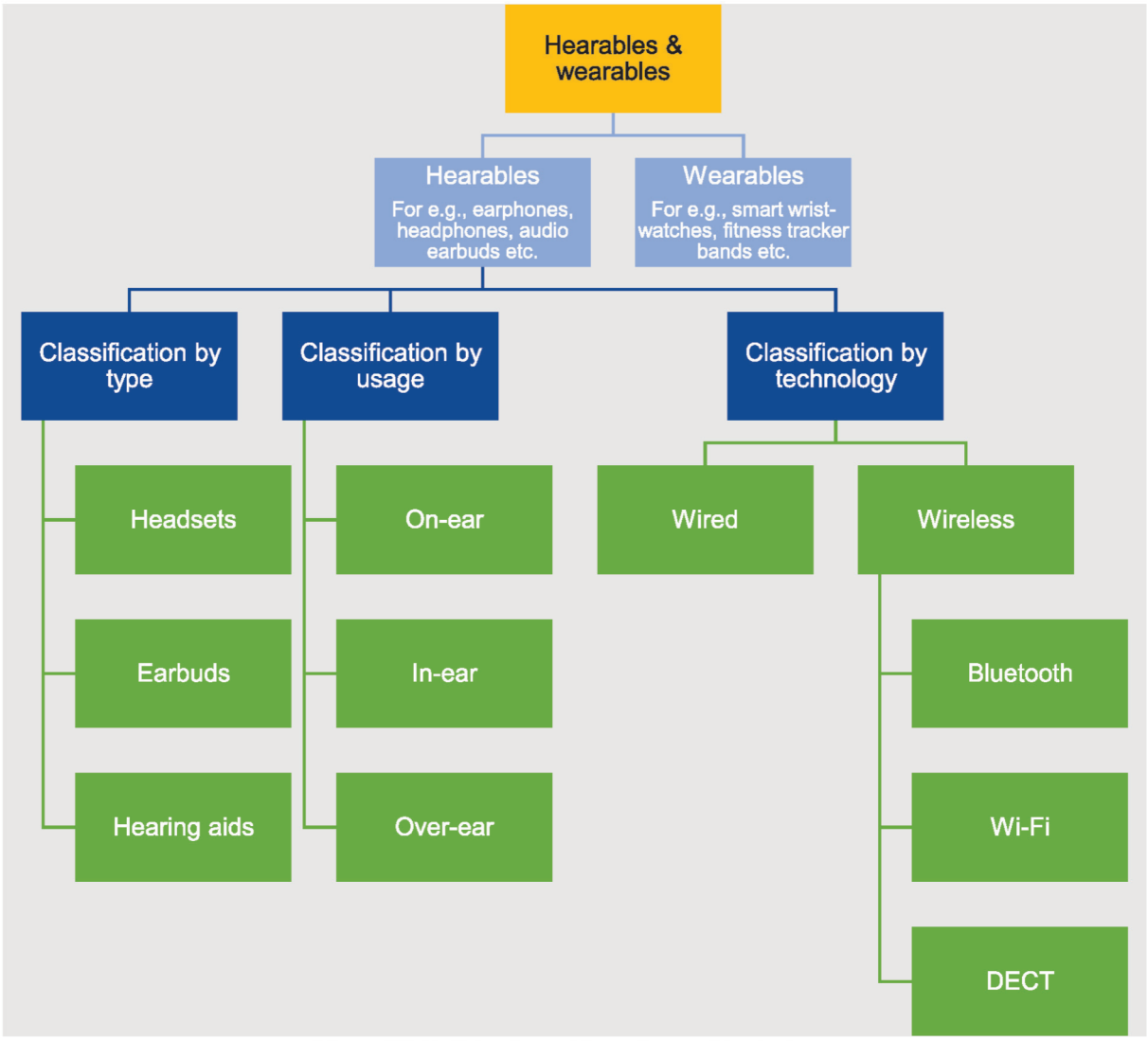



*Figure 72: Defining hearable and wearable devices.*

Based on the type of products, the hearables can be classified as Headsets, Earbuds and Hearing Aids. Based on their physical usage, the hearables can be classified as On-Ear (which are worn just on the visible surface of the ear), In-Ear (which reach the inside of the ear when worn) and Over-Ear (which are worn completely outside over the ear). Based on the connectivity technology used, the hearables can be classified into Wired and Wireless. The wireless segment can be further be classified based on the nature of wireless technology used in the wearable. The wireless segment consists of products using Bluetooth, Wi-Fi, Digital Enhanced Cordless Telecommunications (DECT) technologies among others.

[64] *https://www.alliedmarketresearch.com/hearables-market*

## Hearables & wearables: Global scenario

The global market for earphones and headphones crossed US$ 85 billion in 2021. This is expected to increase to US$ 95 billion by the end of 2022 and keep on increasing at a CAGR of over 11%[65] for at least next 4~5 years. The global shipments may well cross 1 billion units before the end of this decade. In the hearables segment, there has been a very high growth in the wireless sector in the last few years due to significant improvement in the wireless Bluetooth technology and adoption of other technologies like AI for improving the user experience. Further, COVID 19 resulted in more people using earphones as a result of increased working from home. Companies have tapped into the growing sector to establish market share and improve user experiences. Similarly, the smartwatch market recorded a healthy 24% YoY growth in 2021[66].

## Hearables & wearables: Indian scenario

Hearables & wearables is one of the major focus areas of Government of India as part of its vision[67] for broadening and deepening electronics manufacturing in India. The current market size for this segment is low and is just around US$ 1 billion[68]. As much as 90% of this market is comprised of the hearables sub-segment. Till at least 2020-21, the manufacturing base of this sector in India was quite low – with most demand being met through imports. However, over the last couple of years, manufacturing in India has seen a robust growth. As per a report[69], India shipped close to 14 million units of hearables & wearables products during the period Jan-Mar 2022. This was up by 20% during the same period in 2021. In fact, the shipments in smart watches category almost tripled itself over one year.

| Product category | Shipments Jan-Mar 2021 ('000) | Shipments Jan-Mar 2022 ('000) | Year-on-Year Growth |
|---|---|---|---|
| Earwear | 9,425.30 | 9,882.70 | ~ 5% |
| Watches + Wrist band | 2,122.80 | 4,031.20 | ~ 90% |
| **Total** | **11,548.10** | **13,866.00** | **20.1%** |

In fact, specifically in the smart watch category, India's share in global shipments has risen sharply[70] in 2021 from 2020.

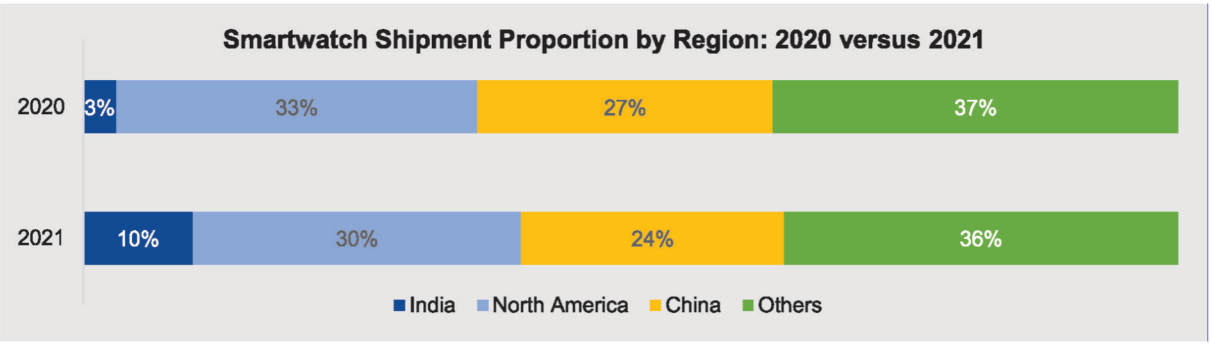



*Figure 73: Smartwatch Shipment Proportion by Region: 2020 versus 2021*

The Government of India Vision document[71] aims to manufacture US$ 8 billion worth of wearables & hearables in India by 2025-26. Out of this, around US$ 2.5 billion would be slated for exports while the

[65] https://www.gminsights.com/industry-analysis/earphone-and-headphone-market
[66] https://www.counterpointresearch.com/global-smartwatch-market-2021/
67 https://static.pib.gov.in/WriteReadData/specificdocs/documents/2022/jan/doc20221247801.pdf
68 https://www.statista.com/outlook/cmo/consumer-electronics/tv-radio-multimedia/headphones/india, https://www.statista.com/outlook/dmo/digital-health/digital-fitness-well-being/digital-fitness-well-being-devices/smartwatches/india
69 https://www.idc.com/getdoc.jsp?containerId=prAP49123222
[70] https://www.counterpointresearch.com/global-smartwatch-market-2021/
71 https://static.pib.gov.in/WriteReadData/specificdocs/documents/2022/jan/doc20221247801.pdf

rest would cater to the Indian market. Therefore, there is a huge potential for an accelerated growth in this sector.

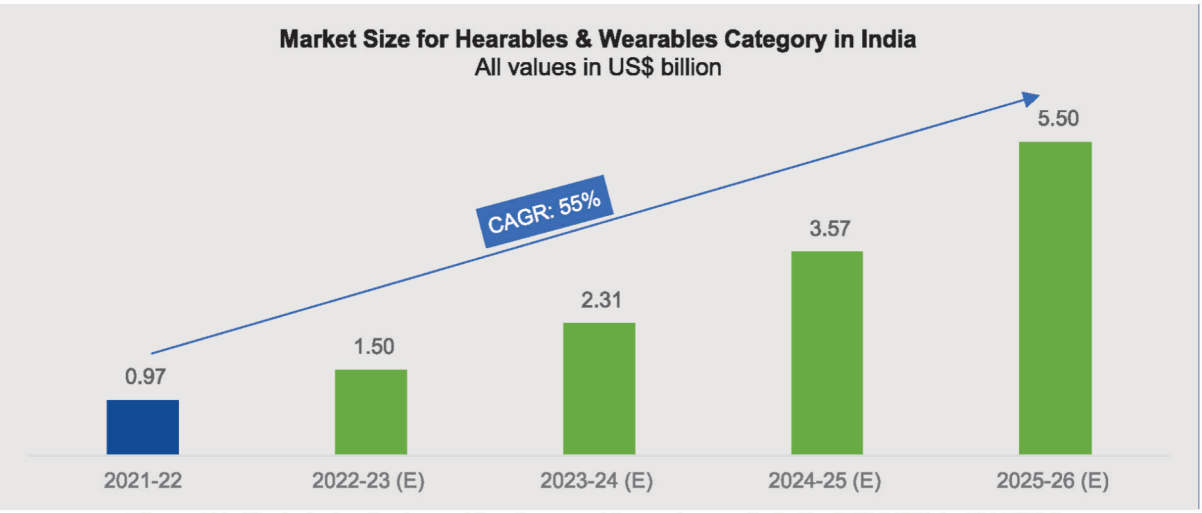



*Figure 74: Market size for hearables & wearables category in India (FY 2021 to FY 2025).*

The key driver for this growth includes increase in usage of hearing devices due to work-from-home culture driven by Covid-19 as well as increase in utilization of the over-the-top (OTT) platforms. This has resulted in entry of many new companies such as RealMe, Xiaomi, etc as well as emergence of many domestic brands like boat, Noise, etc. This in turn has resulted in affordability and accessibility of advanced audio listening devices in the country leading to an increase in sales. Indian brands like boat, Noise, Boult audio and p-Tron have emerged as top brands in this space. Five brands – boAt, Noise, OnePlus, Fire – Boltt and RealMe – account for more than 50% of the share of these devices in India[72]. In fact, according to research[73], nearly 60% of TWS users would prefer boAt as their next TWS purchase. The 2nd brand preferred by consumers for their next TWS purchase would be JBL which would then be followed by Samsung, OnePlus etc. This preference for Indian brands would be another key driver for sharp growth in this sector.

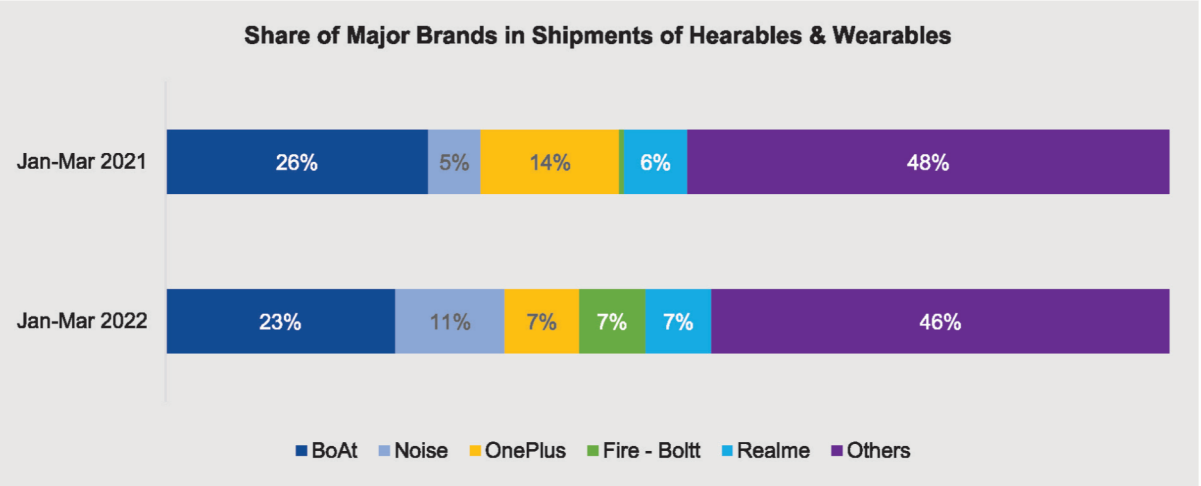



*Figure 75: Share of Major Brands in Shipments of Hearables & Wearables*

Local manufacturing is being increasingly preferred by many these brands to improve margins, reduce dependence on Chinese imports and to gain more control of their supply chain. Many companies like boAt, Noise, etc have already partially started manufacturing in India. Local production grew to 14% this quarter from about 6.5% in the previous quarter with a 113% QoQ growth[74]. This increase in domestic production has translated to an overall YoY decline of 19% in the Average Selling Price (ASP)

*72 https://www.idc.com/getdoc.jsp?containerId=prAP49123222*
*73 https://www.counterpointresearch.com/survey-tws-users-india/*
*74 https://www.counterpointresearch.com/india-tws-shipments-grow-66-yoy-q1-2022-local-brands-capture-4-top-5-spots/*

in Q1 2022. Going forward, a major increase in domestic manufacturing is expected from brands like Noise, boAt and RealMe.

In line with the objective to increase domestic manufacturing of wearables and hearables in India, the government has also announced a Phased Manufacturing Programme (PMP). Under this, the duty on most components used for manufacturing wearables and hearables will be brought down to nil while customs duty on imports of such products will be charged at 15-20% over FY23-26[75]. There is provision for further calibration of duty rates to provide a graded rate structure which will facilitate domestic manufacturing of wearable devices, hearable devices and electronic smart meters.

Growth in this segment can also be attributed to the initiatives like the Production Linked Incentive (PLI) schemes for mobile phone manufacturing in India. Companies are looking to make their products locally using the facilities provided by the PLI scheme linked local manufacturers. Optiemus electronics is a domestic manufacturer that is approved to receive the benefits of the governments PLI scheme. Now it has started making hearables and wearables products at its Noida plants for Nexxbase Marketing Pvt. Ltd., the maker of the Noise brand of smartwatches and headphones[76]. The company started domestic production with Optiemus in August and makes 25% of its products in India[77]. This share is expected to rise 50-60% by the end of 2022. To achieve this, Noise has partnered with 4-5 equipment makers including Optiemus Electronics and Taiwan's Foxconn.

Other brands have also got on the ride to manufacture locally with Mivi launching its first made-in-India TWS device DuoPods A25 in 2021[78]. Mivi is the 2nd brand to launch a Made-In-India TWS product after pTron. boAt has also decided to shift most of its manufacturing base to India to provide more affordable devices. boAt and Dixon Technologies formed Joint Venture in May to design and manufacture wireless audio solutions in India. Both companies will partner to evolve the Indian mobile accessory market in a 50-50 venture[79]. boat has also set up a new research and development centre in Bengaluru this year. Ambrane, a company specialising in selling power banks in India has ventured into the smartwatch market in 2022[80].

## Manpower requirement

The current manpower employed in this sector is quite low and is estimated to be less than 10,000 personnel employed in various roles – both on permanent and contract basis. Sales and marketing is the major function[81]. Table below lists the employee strength (as listed on LinkedIn) of some of the major wearable & hearable companies.

*Figure 76: Number of employees listed on LinkedIn for top companies in wearables & hearables segment in India*

| Company | Hearables | Wearables | Employees Listed on LinkedIn |
|---|---|---|---|
| boAt | Yes | Yes | 430 |
| Noise | | Yes | 202 |
| OnePlus | Yes | Yes | 1,200 |
| Fire-Boltt | | Yes | 29 |
| RealMe | Yes | Yes | 427 |
| Zebronics | Yes | Yes | 604 |
| Bose | Yes | | 503 |

[75] *https://knnindia.co.in/news/newsdetails/sectors/phased-manufacturing-programme-to-promote-domestic-manufacturing-of-wearables*
[76] *https://www.livemint.com/industry/manufacturing/wearables-hearables-makers-ramp-up-local-manufacturing-11640112265441.html*
[77] *https://www.livemint.com/technology/tech-news/noise-to-double-local-mfg-headcount-11654796494717.html*
[78] *https://www.gadgetsnow.com/slideshows/tws-earbuds-and-headphones-market-in-india-top-companies-popular-models-and-features/photolist/85390261.cms?picid=85390273*
[79] *https://www.boat-lifestyle.com/blogs/news/boat-and-dixon-technologies-form-joint-venture-to-design-and-manufacture-wireless-audio-solutions-in-india*
[80] *https://www.livemint.com/industry/manufacturing/wearables-hearables-makers-ramp-up-local-manufacturing-11640112265441.html*
[81] *LinkedIn; Kantar analysis.*

| Company | Hearables | Wearables | Employees Listed on LinkedIn |
|---|---|---|---|
| Times | | Yes | 466 |
| Chumbak | | Yes | 264 |
| JBL | Yes | | 219 |
| iBall (India) | Yes | | 167 |
| Ambrane | Yes | | 157 |
| Miniso | Yes | | 156 |
| French Connection | | Yes | 148 |
| Portronics | Yes | Yes | 146 |
| Fitbit | | Yes | 142 |
| Garmin | | Yes | 126 |
| Others | --- | --- | ~ 600 |
| **Total** | **---** | **---** | **~ 6,000** |

It is to be noted that the above employee base largely comprises of sales and marketing personnel who work across multiple product categories. For e.g., most of the 1,200 OnePlus employees would be working as sales and marketing personnel for its various product categories including mobile phones. Therefore, the above value would be more than the most optimistic estimate of manpower currently employed in the wearables and hearables segment. However, since LinkedIn usually has permanent employees in white collar roles, we can safely assume that even by adding contractual employees (who largely work in production roles), the maximum number of employees would be around 10,000.

However, as the sector grows rapidly and the production expands, this manpower requirement can be expected to increase multi-fold and with a greater proportion, than current, staff in production roles.

The rate of growth for manpower has been considered in two ways:

1. Since the sector is likely to grow at around 50% CAGR, the manpower requirement can also be assumed to be growing at a similar rate as the sector is still in its nascent stages.

   Using this approach, the wearables and hearables sector is projected to employ just over 50,000 personnel by 2025-26.

2. As per the Government of India's policy document in electronics sector[82], 134 units in electronics sector, approved under M-SIPS schemes, have commenced production. These units reported total sales of INR 74,921 crores (~ US$ 9.46 billion[83]) and have generated employment for around 66,500 persons (direct and indirect). Assuming that similar skills and profiles of manpower would be required for wearables and hearables sector, each US$ 1 billion of production/revenue is likely to generate around 7,000 jobs. Therefore, to achieve a total production of US$ 8 billion, a manpower strength of around 56,000 personnel would be required.

**A conservative estimate of manpower requirement for this sector in 2025-26 would be around 50,000 which is 5 times the manpower currently employed by this sector.**

*82 https://www.meity.gov.in/writereaddata/files/Notification_NPE2019_dated25.02.2019.pdf*
*83 As on 6th July 2022.*

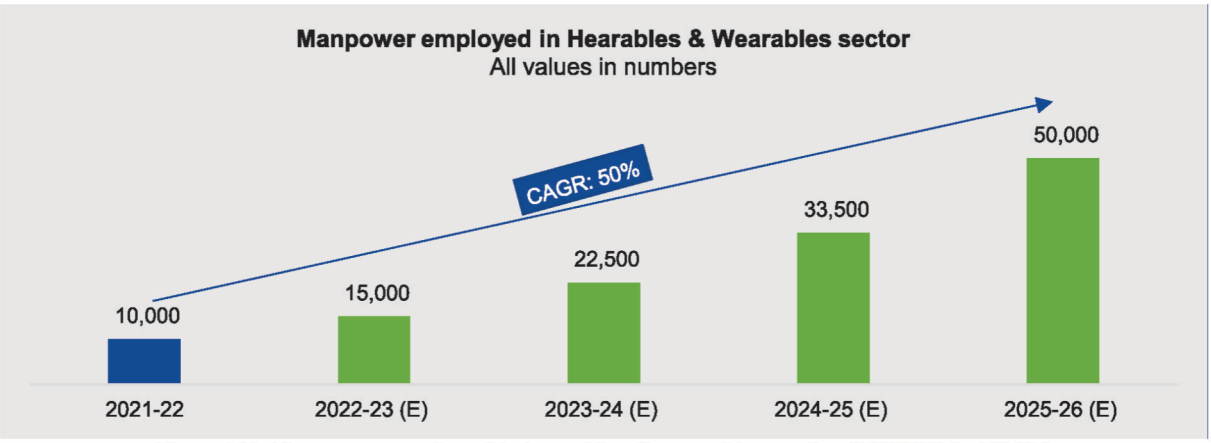



*Figure 77: Manpower employed in hearables & wearables sector (FY 2021 to FY 25)*

# Major job roles, required skills and upskilling practices

## Major job roles

Hearables and wearables, traditionally, have largely been imported into India. While there are now some players who have now started manufacturing in India, a large part of the work force, both permanent and contractual, still belong to sales/marketing and after-sales services.

Other key job roles, apart from sales and marketing, include:

1. Product Designer
2. Graphic Designers / Motion Graphic Designers
3. Content Writer
4. Website Designer
5. Tester / Quality Control Engineer
6. Customer Relationship Manager

> Sales is a very important role in our organization. The only problem is that salespeople are volatile people – they keep on changing. Apart from that graphic designing is important. Another very important role is that of customer relationship manager. Generally, attrition is not there in this department, but it is very important as when people buy products, they need to have a touchpoint when you face a problem. Therefore, customer care has to be good.
>
> **– Wearable/hearable company**

## Critical skills: Technical

Some of the key skills required for major job roles in this sector are listed below:

*Figure 78: Top skills required for major job roles in hearables and wearables sector*

| Job Roles | Key skills[84] |
|---|---|
| **Sales and/or marketing manager** | Marketing, Event management, Influencer Marketing, Negotiation, Advance Excel. |
| **Product Designer** | B2C software and services, Mobile App services, UX Design. |
| **Graphic Designers / Motion Graphic Designers** | Adobe Photoshop, Illustrator, Project Management Skills, Trend Awareness, End Slates, Stop motion, 3D renders and Motion graphics for Ad, AfterEffects, Adobe Premier Pro. |
| **Content Writer** | Campaign Budgets, Brand Strategy, Interpersonal Verbal and Written Skills, Decision Making, Strong Organizational Skills. |

[84] *Sources: LinkedIn, Naukri.com, Kantar primary research.*

| | |
|---|---|
| **Website Designer** | Manging of E-commerce Websites and Portals, SEO, Strong Communication Skills, Hosting and Server management, Maintain Website content. |
| **Tester / Quality Control Engineer** | R&D, Altium, Test Engineering, Speakers. |
| **Customer Relationship Manager** | Customer Support, Query Solving, Client Satisfaction, Customer Service, Customer care. |

Apart from the above specific job role wise skills, top general technical skills considered critical, by employees in hearables & wearables sector, are quality control/assurance, basic knowledge of computer hardware/software, awareness of basic electronics/electrical concepts and data analytics.

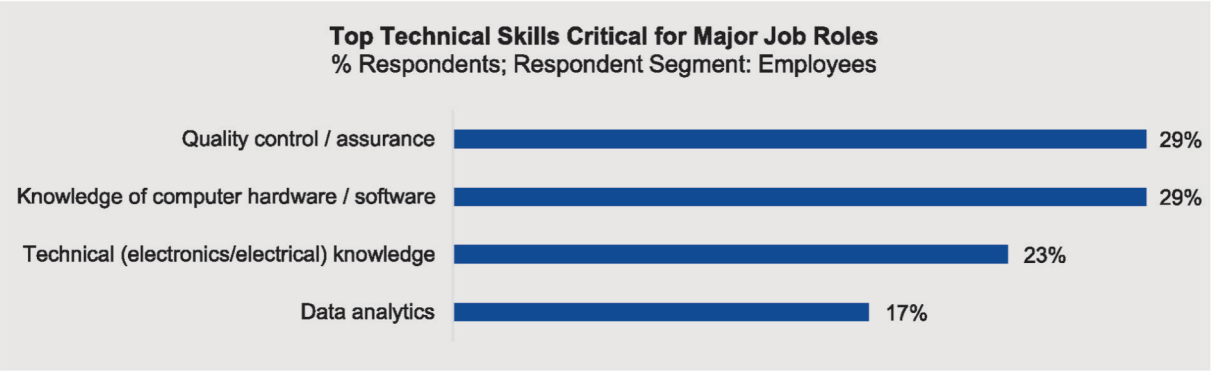



*Figure 79: Top technical skills critical for major job roles (hearables & wearables)*

> Testing engineer needs to be a person who is a diploma holder in electronics or, even better a B.Tech. There also we have a bifurcation in terms of new product testing and old product testing. Latter is important in case of any return/replacement request. We need to get that product tested too before getting repaired."
>
> **– Wearable/hearable company**

> *Skills required in wearables and hearables category are threefold – hardware, software in the product and software in the mobile. When the product team finalizes the features, it is the role of the design team to decide which components and sensors to use. Also, you need a software on the device to make sense of the raw data you get from the sensors. Then you also need an app on your mobile to use that wearable or hearable device. So a person in this field needs to have these skills.*
>
> **– Wearable/hearable company**

> *One needs to know technical aspects of the products. We have a motherboard – which we call as PCBA. You need to choose the right components, understand the power consumption, accordingly choose right power source and ensure the safety of the system. One needs to ensure the safety of the system. It should not happen that a watch catches fire because of being heated while being worn on a human wrist. Design team needs to understand all of this.*
>
> **– Wearable/hearable company**

Basic technical awareness of electronics/electrical systems as well as computer hardware/software along with quality control/assurance systems are the top-3 relevant technical skills for job security and prospects of promotion.

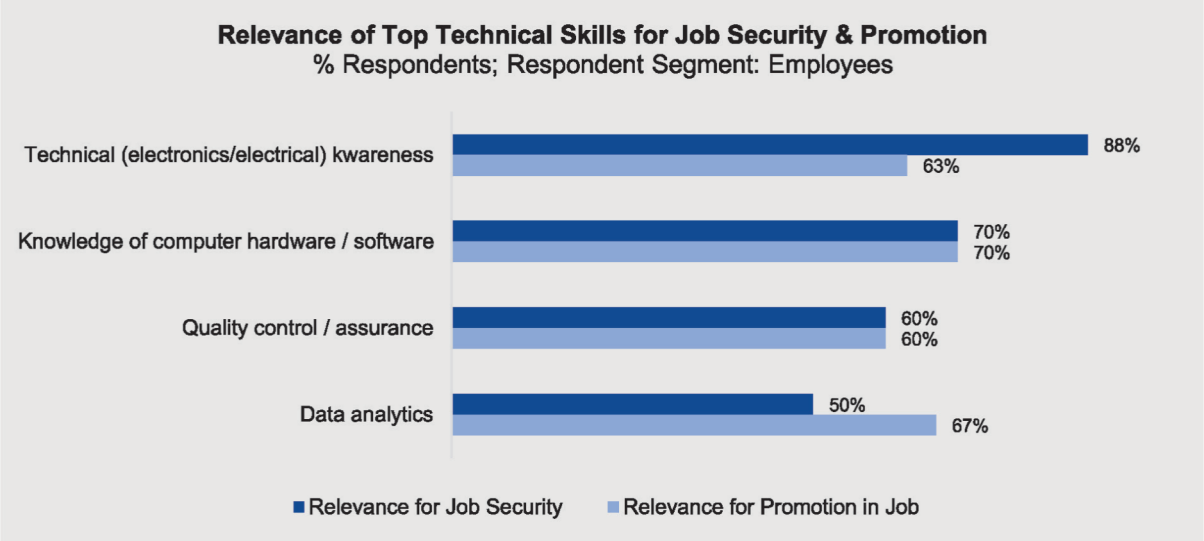



*Figure 80: Relevance of top technical skills for job security and promotion (hearables & wearables)*

Employees, generally, feel that they have an advance, or even expert, level of proficiency levels in these skills. However, basic technical awareness of electronics/electrical systems and testing are two key areas where they assess themselves to be somewhat lacking in proficiency.

> *Some bit of background in electronics – especially electronics and communication engineering – will help as it really helps in understanding the concepts.*
>
> **– Wearable/hearable company**

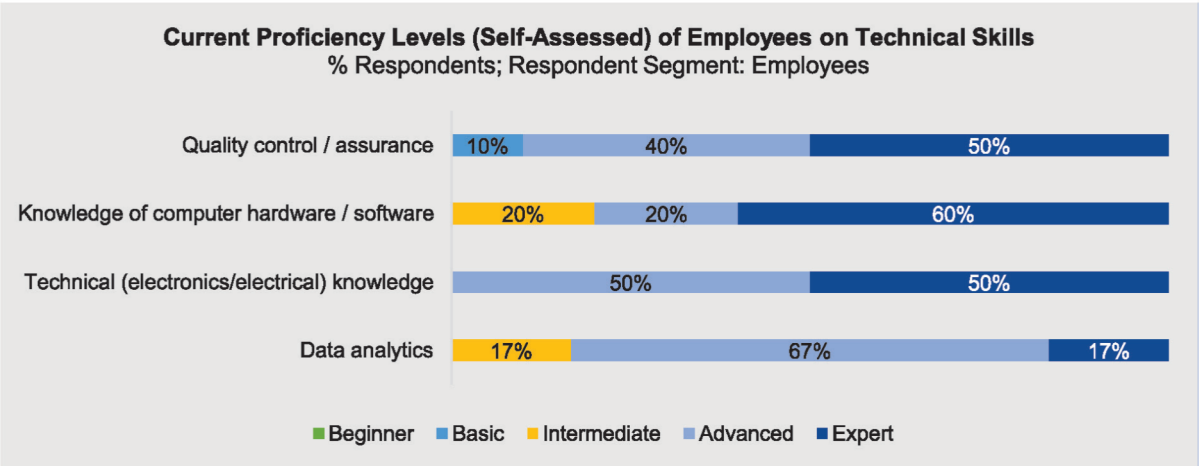



*Figure 81: Current proficiency levels of employees on top technical skills (hearables & wearables)*

**Wearables and hearables industry is very nascent, and the roles and skills are still evolving. However, it is unlikely that any of the current roles will go out of phase anytime soon – whether its sales/after sales or technical roles. In fact, as production in India gains traction, the technical or production roles are likely to get even larger and more important. In such cases, the depth of skills required would increase.**

## Critical skills: Non-technical

Communication skills, project or production management, leadership / team management and problem identification & solving skills are the top non-technical skills required for major job roles in the EMS sub-sector.

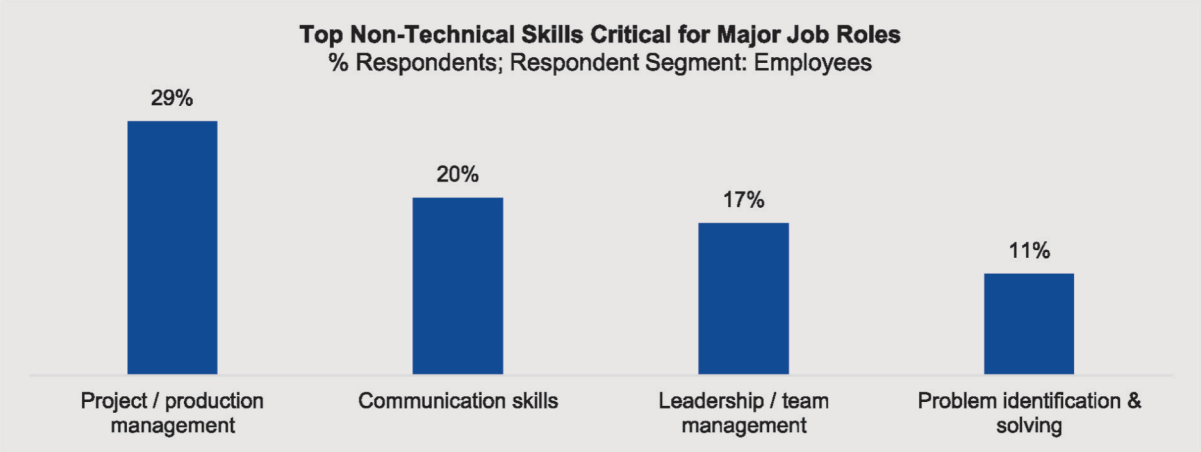



*Figure 82: Top non-technical skills critical for major job roles (hearables & wearables)*

> *An important skill is to understand the consumer – their pain points and their expectations. What does the consumer need? What do they want? What is the technology availability? And how do we use that technology to give a feature that a consumer wants."*
>
> **– Wearable/hearable company**

The most relevant of these skills, for job security and prospects for promotion, are project or production management and communication skills.

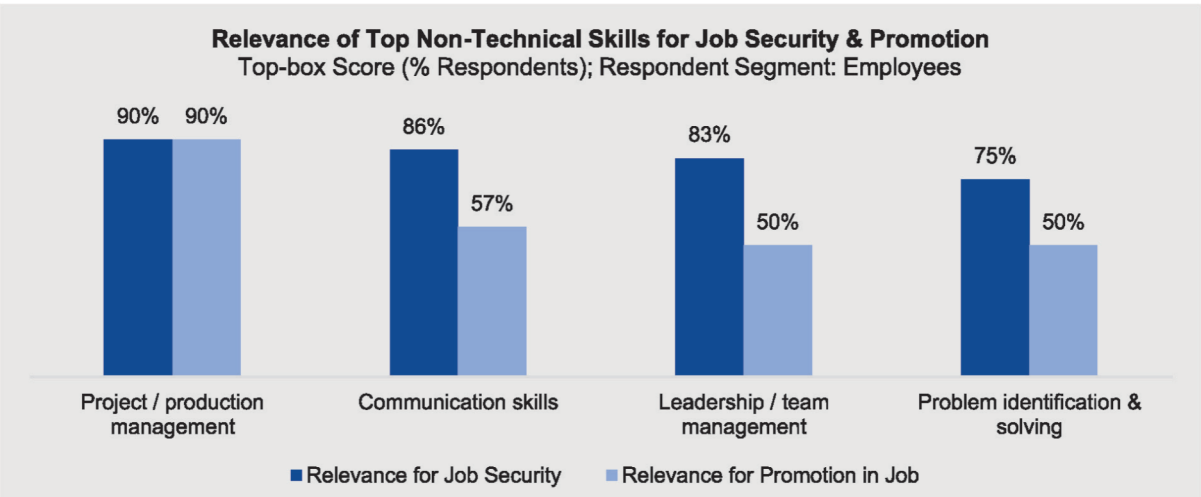



*Figure 83: Relevance of top non-technical skills for job security and promotion (hearables & wearables)*

## Training practices: Internal and/or external

There are over 375 training institutes, across India, which have partnered with ESSCI to provide training to personnel for becoming job ready in electronics sector. Top-5 courses (in terms of absolute enrolment), which these training institutes provide for students aiming for jobs in wearables & hearables category include Electronic Hardware Design Engineer, Embedded Software Engineer, Testing &, Validation Engineer, Mechanical Fitter and Assembly Supervisor.

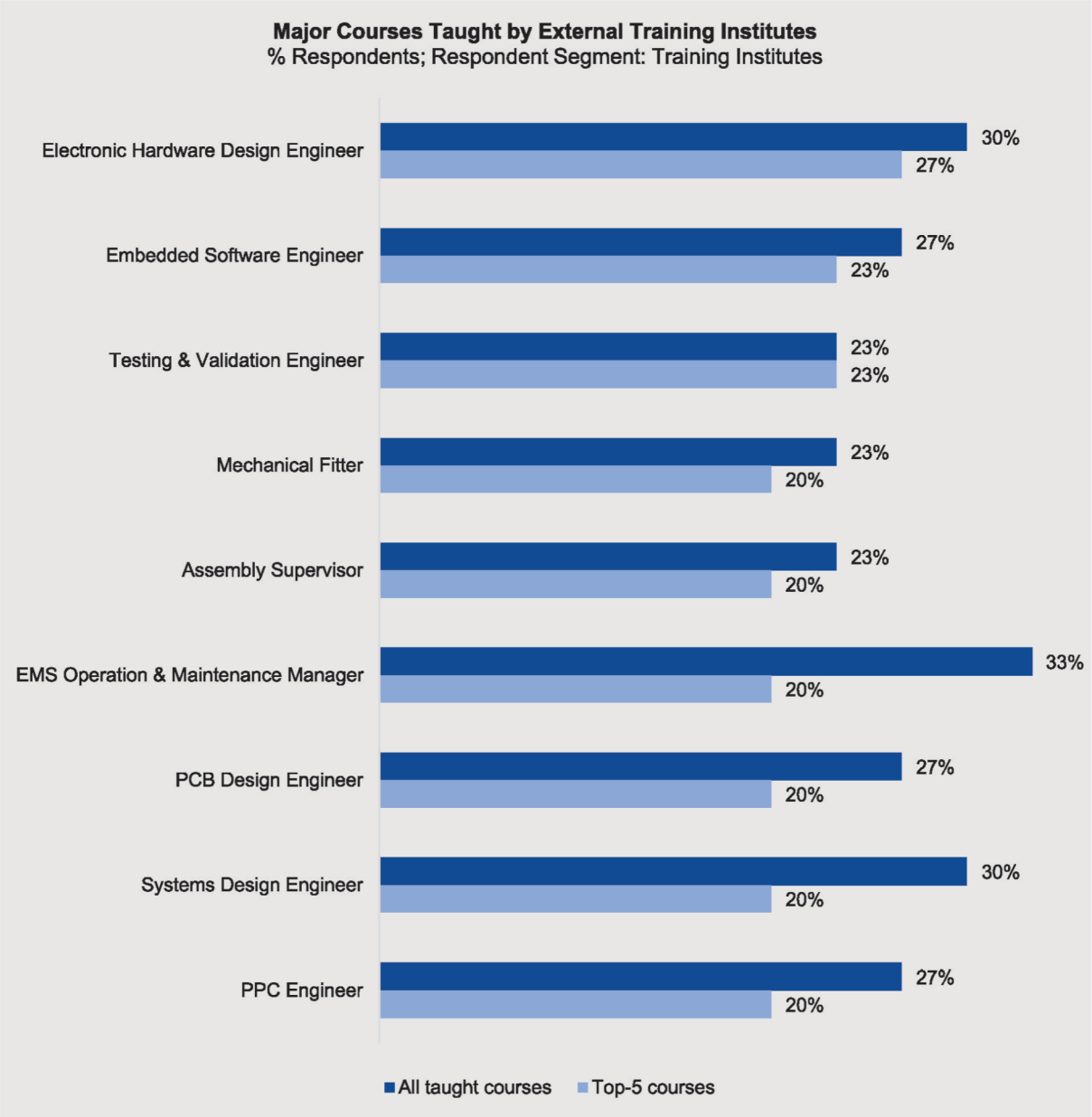



*Figure 84: Major courses (for job roles) taught by ESSCI approved training institutes (hearables & wearables)*

In view of external training institutes, hearable & wearable job roles which hold top importance are **PPC Engineer, Systems Design Engineer, Embedded Software Engineer and Mechanical Fitter**. Not only are these job roles high in demand among trainees, as shown by enrolment levels to the training courses, but are also deemed highly relevant for job prospects, security and promotion by these training institutes.

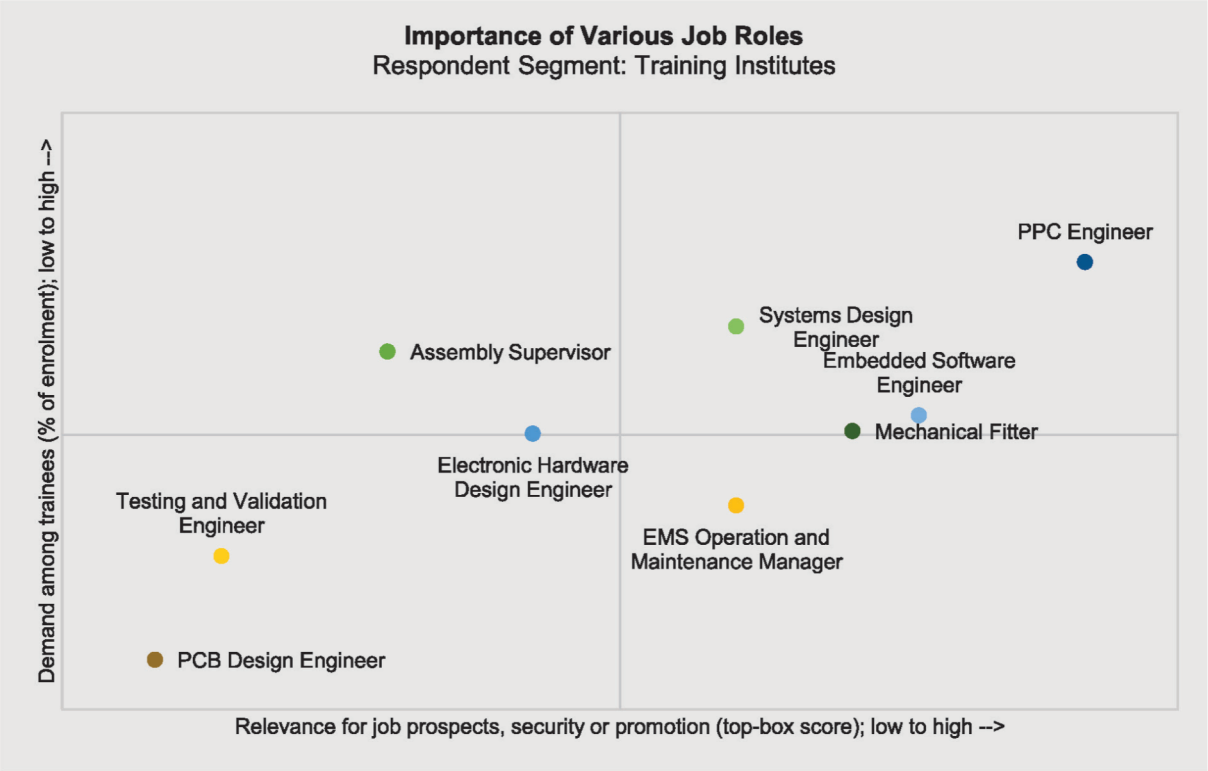



*Figure 85: Importance of various job roles (hearables & wearables)*

The two key challenges which training institutes face in providing training in wearables and hearables sub-sector are quality and availability of instructors as well as demand for courses/programs among students.

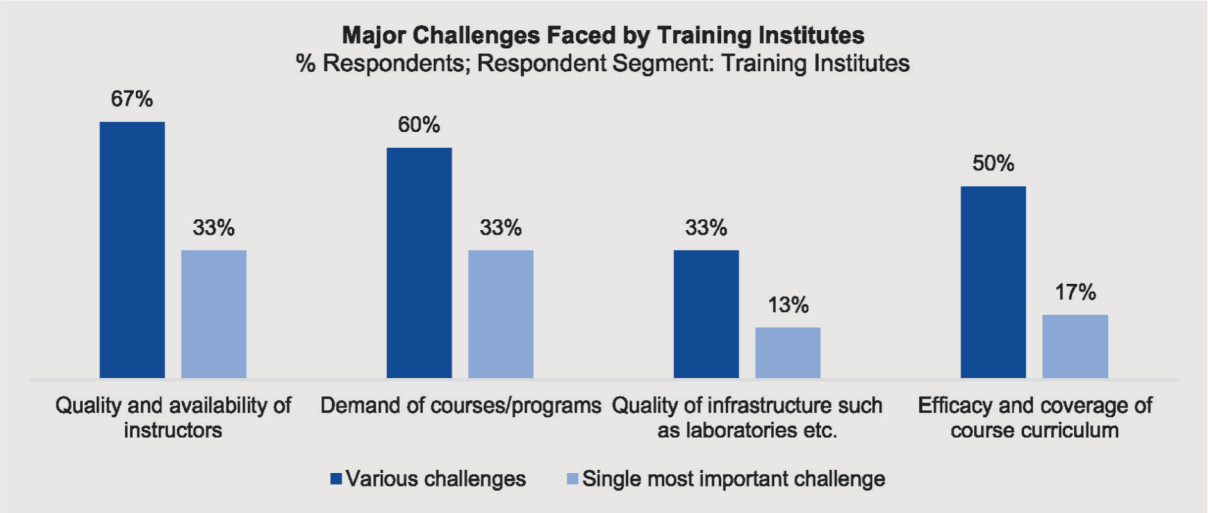



*Figure 86: Challenges faced by training institutes (hearables & wearables)*

## Upskilling practices by employees

Employees in various companies operating in electronics manufacturing sector actively strive to keep themselves upskilled in order to remain relevant in the ever-changing job market. However, they face multiple challenges to remain upskilled. The most common challenges faced by them are the lack of time and lack of training resources outside organization.

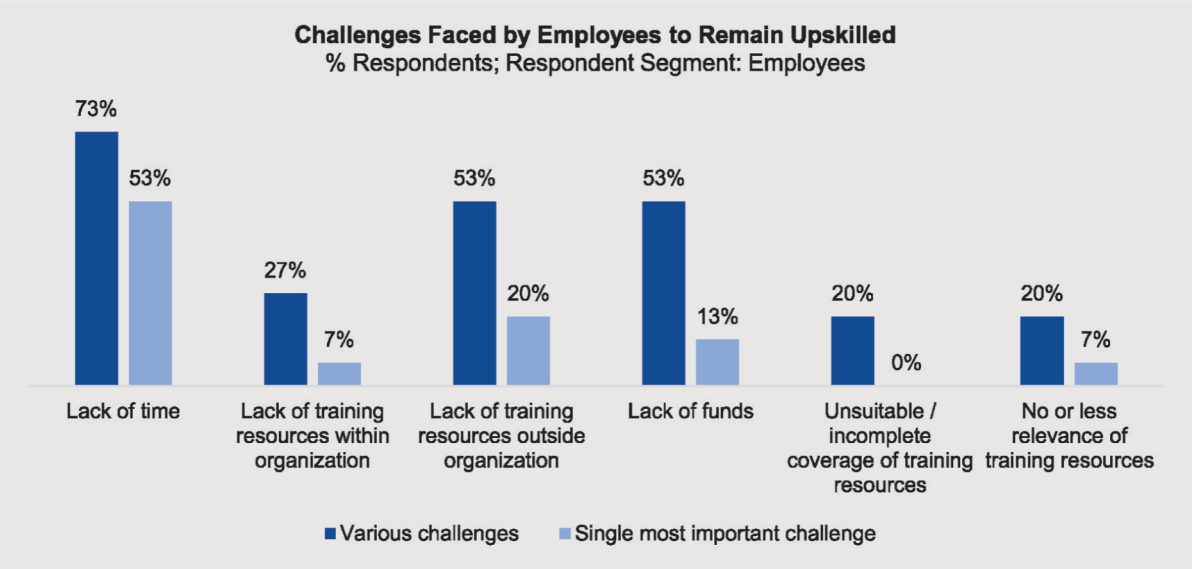



*Figure 87: Challenges faced by employees to remain upskilled (hearables & wearables)*

The largest mode of training received by employees in their company is on-job training followed by training company training portal (or other online training courses funded by the company).

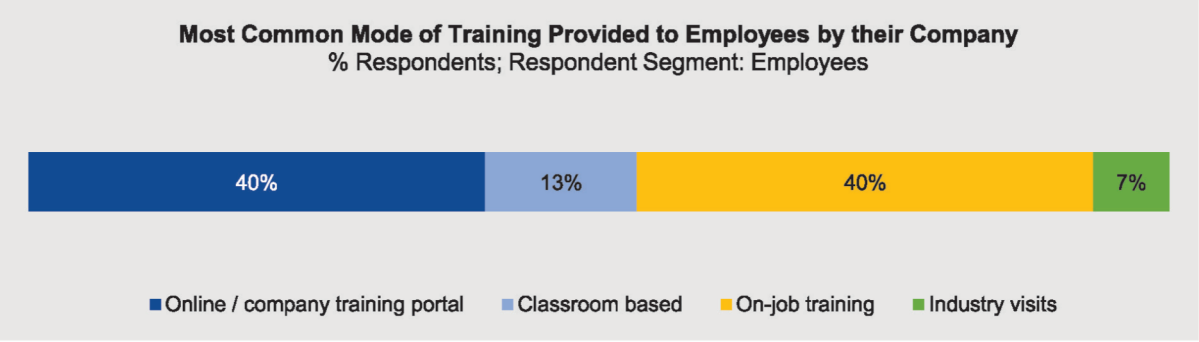



*Figure 88: Common modes of training provided to employees by companies (hearables & wearables)*

Most employees not only find the coverage of course curriculum, of in-house training, adequate but also relevant for increasing their efficiency and efficacy in their jobs.

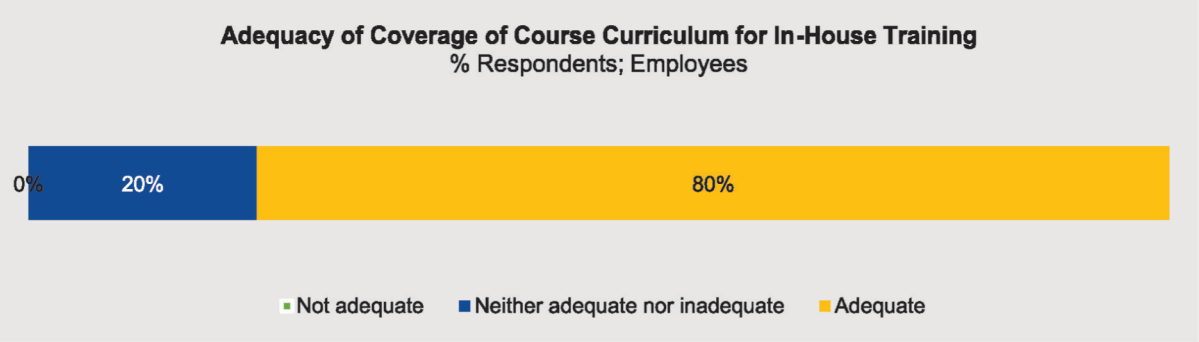



*Figure 89: Adequacy of coverage of course curriculum for in-house training (hearables & wearables)*

Apart from being trained by their company, many of these employees also use external sources of training – most commonly being online/MOOC courses available on Coursera, Unacademy, eDX etc. – to remain upskilled. Many of them also taken for industry visits by their companies (or, rarely, on self-initiative).

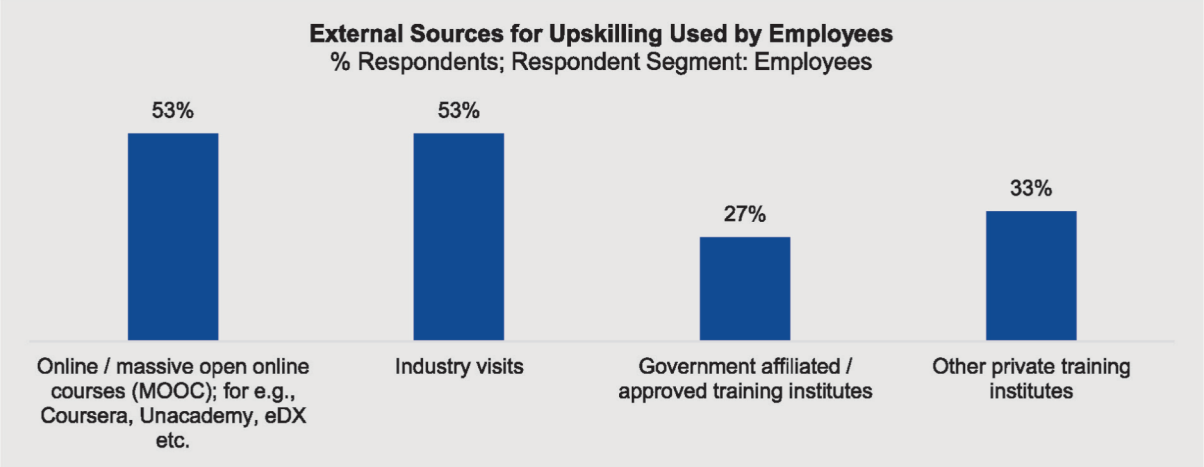



*Figure 90:External sources of training used by employees for upskilling (hearables & wearables)*

Industry visits, followed by government approved training institutes, are generally considered the best in terms of their coverage of training material.

Interestingly, while online/MOOC courses are preferred by a large percentage of employees, very few find the coverage there as excellent.

> *I don't know what sort of courses are available to help an employee upskill for our product categories. This is a relatively new industry and I do not see any specific courses that people can go and train in. There are courses on AI and on IoT and even on project management etc. but nothing very specific in our domain.*
>
> **– Wearable/hearable company**

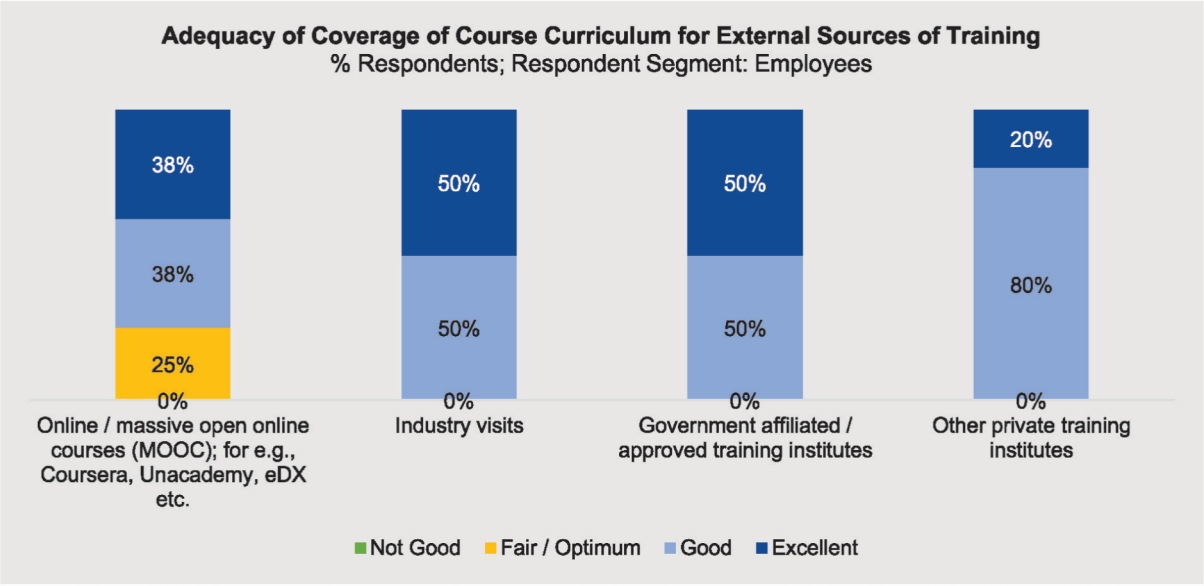



*Figure 91: Adequacy of coverage of course curriculum for external training (hearables & wearables)*

Training and experience provided by industry visits are also considered among the best for increasing efficiency and efficacy of their jobs.

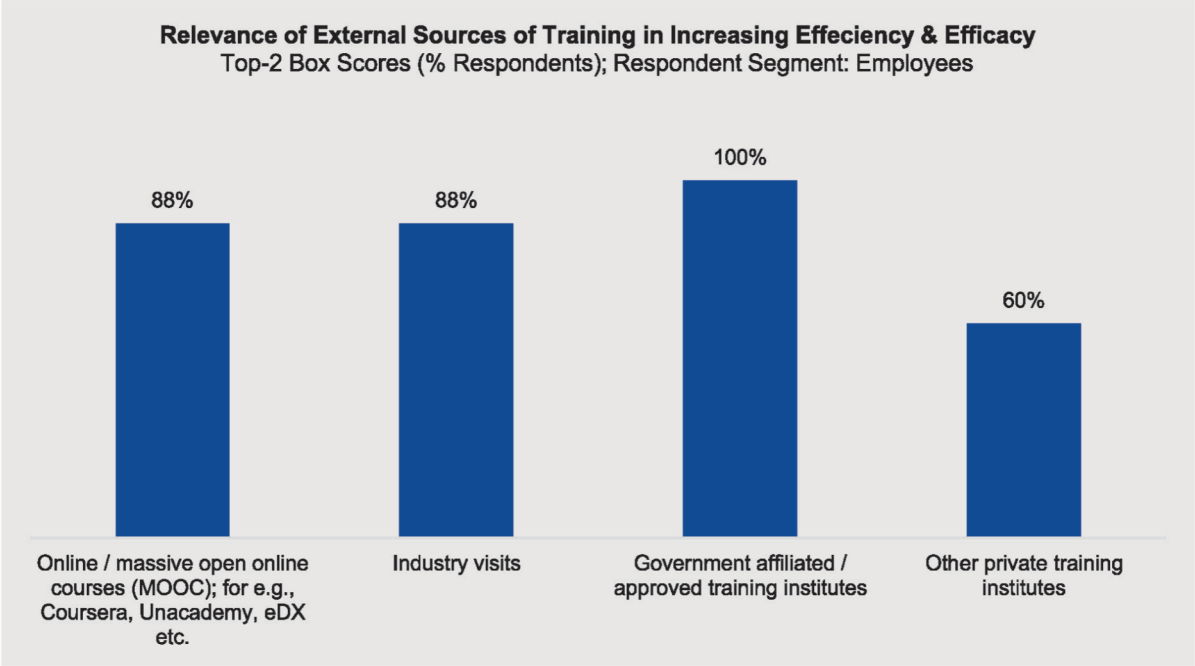
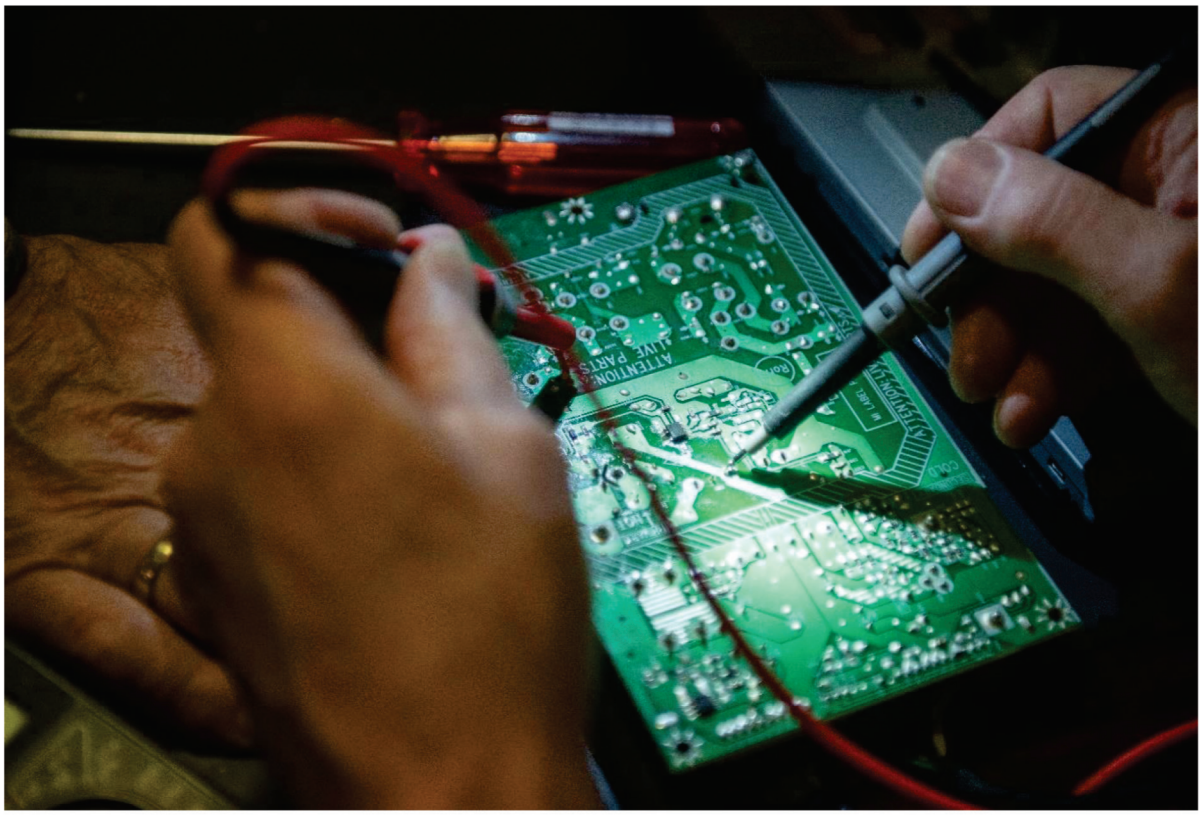



*Figure 92: Relevance of external training in increasing efficiency & efficacy of employees (hearables & wearables)*



# Circularity / e-waste management

## Introduction

As per E-waste Management Rules, 2016[85], e-waste refers to '*electrical and electronic equipment, whole or in part discarded as waste by the consumer or bulk consumer as well as rejects from manufacturing, refurbishment and repair processes*. These equipment's include IT & telecom equipment such as computers & computing devices, printers, copiers, fax/telex, telephones (corded & cordless), cellular phones, answering systems as well as consumer durables such as television, refrigerator, washing machines, air-conditioners and fluorescent lamps.

An estimated 57.4 Metric Tonnes of e-waste was generated globally in 2021. Out of this, less than 20% was collected and recycled[86]. India is the third largest electronic waste producer in the world[87] after China and US.

E-waste management is a vast sector with a value chain spanning from collection (which involves a huge number of garbage collectors in unorganized domain as well as organized collection efforts of electronic products OEMs), aggregation, segregation, dismantling and recycling.


*Figure 93: E-waste value chain in India*

There are, therefore, multiple stakeholders with roles & responsibilities spanning across multiple nodes of the above value chain. These are, briefly, discussed below:

*Figure 94: Major stakeholders in e-waste generation and management ecosystem*

| Stakeholder | Roles and Responsibilities |
|---|---|
| Govt. Agencies (Central and State) | — Lays the regulatory framework.<br>— Oversees implementation of these regulations. |
| Producers, Manufacturers | — Organize, finance, and operate e-waste take back system, either individually or collectively, through PROs. |
| Producer Responsibility Organisations (PROs) | — Operate e-waste take back systems on behalf of producers.<br>— Ensure collected e-waste is transported to appropriate treatment centres and properly treated. |
| Retailers | — Less participation in the e-waste collection. Might provide a take back scheme for some products. |
| Consumers | — Individual and bulk (Government and businesses) consumers determine the fate and route of e-waste management and are an important part of the ecosystem. |
| Waste collectors | — Responsible for the collection of the waste.<br>— Mostly dominated by informal collectors. |

[85] https://cpcb.nic.in/displaypdf.php?id=RS1XYXN0ZS9FLVdhc3RlTV9SdWxlc18yMDE2LnBkZg==
[86] https://en.wikipedia.org/wiki/Electronic_waste
[87] https://en.wikipedia.org/wiki/Electronic_waste_in_India

| Stakeholder | Roles and Responsibilities |
|---|---|
| Recyclers | — Responsible for recycling and recovery of items.<br>— Formal recyclers use modern techniques for proper recycling whereas Informal recyclers who carry out pre-processing and rudimentary material recycling may use inefficient techniques which can contribute to adverse effect in human health and the environment. |
| Refurbishing agents | — Process the reusable items for secondary use. |
| Civil Society and Development Organisations | — Bring awareness about the e-waste issues and knowledge transfer and stakeholder interactions. |

## E-waste: Indian scenario

Revenue is generated for relevant stakeholders at each stage of this value chain. However, due to highly unorganized nature of this industry, there is no estimate, so far, regarding the total value of e-waste management 'market' in India. The only clear estimate is that of total e-waste generation in the country – which is estimated to be around 3.2 million metric tonnes (MMT) in 2019[88]. This considers into account all 21 types of electrical and electronic equipment listed in E-Waste Management Rules, 2016. It is estimated that by the year 2025, total e-waste generation is likely to reach around 11.5 MMT[89].

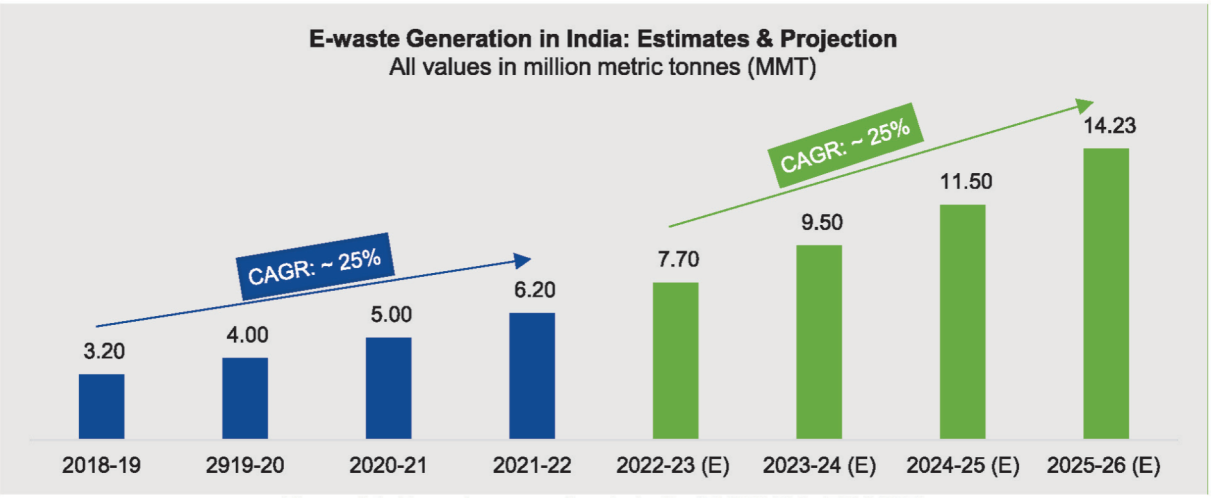



*Figure 95: E-waste generation in India (FY 2018 to FY 2025)*

Various factors that would drive the growth of e-waste generation include:

1. **Consumer demand:** Consumer demand for electronic and electronic products – especially connected devices (IoT) – has been growing over the years. This is likely to grow even further as disposable incomes increase, prices reduce, and financial products allow increased purchase of products. Interestingly, Covid-19 played a dual role towards e-waste generation and recycling in the country. As almost all companies instituted work-from-home policies, demand for computers and its peripherals grew in the country leading to increased e-waste generation. At the same time, due to restrictions on logistics – at the peak of Covid-19 – the collection efforts almost reduced to a halt so much so that the government had to step-in and relax the collection/recycling quotas that had to be met by the electronic/electrical devices OEMs.

2. **Increasing awareness:** While e-waste generation is a given (whatever is manufactured will also reach its end-of-life eventually), the actual collection and recycling is much lower than the e-waste generation. A key reason for this is that most generated e-waste lies in the homes and institutions of their erstwhile users. There has been, both, a lack of awareness of e-waste

*88 https://www.meity.gov.in/writereaddata/files/Circular_Economy_EEE-MeitY-May2021-ver7.pdf*
*89 https://www.frost.com/frost-perspectives/electronic-waste-management-in-india-market-growth-trajectory-and-future-potential/*

recycling as well as lack of proper collection efforts. As the awareness towards environmental conservation is rising, more and more users are likely to send the e-waste generated by them for recycling. This will be a key driver for growth.

3. **Tighter regulations:** Government is likely to tighten the regulations under the EPR (Extended Producer Responsibility) Policy whereby the targets for recovery of electronic/electrical waste are likely to be increased. Such a policy, when implemented, would increase the amount of e-waste collected and recycled.

4. **Changing technology:** Changing technology is a double-edged sword. One of the impacts of this could be reducing size of the equipment even as the volumes grow up. As the products become more affordable, the volumes of sales would go up, but the overall weight may follow a different trajectory. This would have an impact on growth/de-growth of e-waste generation.

However, the actual collection and recycling of e-waste in India is quite low as compared to its generation. As per Central Pollution Control Board[90], there are more than 450 dismantlers and recyclers in India with a combined installed capacity of 1.43 MMTA (million metric tonnes per annum) as of April 2022. State wise numbers of dismantlers & recyclers along with total installed capacity is given below.

*Figure 96: State-wise authorized dismantlers & recyclers in India*

| No | State/UT | No. of Authorized Dismantlers & Recyclers | Installed Capacity *In Metric Tonnes Per Annum (MTA)* |
|---|---|---|---|
| 1 | Andhra Pradesh | 8 | 32,123 |
| 2 | Assam | 1 | 120 |
| 3 | Chhattisgarh | 2 | 6,750 |
| 4 | Delhi | 2 | 120 |
| 5 | Gujarat | 33 | 84,302 |
| 6 | Goa | 1 | 103 |
| 7 | Haryana | 42 | 1,37,416 |
| 8 | Himachal Pradesh | 2 | 1,500 |
| 9 | Jammu & Kashmir | 3 | 705 |
| 10 | Jharkhand | 2 | 660 |
| 11 | Karnataka | 71 | 52,842 |
| 12 | Kerala | 1 | 1,200 |
| 13 | Maharashtra | 116 | 1,06,281 |
| 14 | Madhya Pradesh | 2 | 9,600 |
| 15 | Orissa | 5 | 5,690 |
| 16 | Punjab | 7 | 9,492 |
| 17 | Rajasthan | 24 | 83,604 |
| 18 | Tamil Nadu | 32 | 1,32,049 |
| 19 | Telangana | 17 | 1,13,012 |
| 20 | Uttar Pradesh | 89 | 4,94,043 |
| 21 | Uttarakhand | 6 | 1,53,125 |
| 22 | West Bengal | 4 | 1,950 |
| **Total** | | **470** | **14,26,685** |

While the installed capacity is just below 25% of the total e-waste generation, the actual collection is even lower – to the tune of around 10% of total e-waste generation[91].

*90 https://cpcb.nic.in/uploads/Projects/E-Waste/List_of_E-waste_Recycler.pdf*
*91 https://www.downtoearth.org.in/news/waste/india-collected-just-3-e-waste-generated-in-2018-10-in-2019-cpcb-report-75072*

This is a very low collection and recycle rate in comparison to the other e-waste recycling countries in the world, especially considering the amount of e-waste being generated each year. In India[92], the Ministry of Environment, Forests, and Climate Change (MoEFCC) is responsible primarily for the regulations including e-waste. The Central Pollution and Control Board (CPCB) and State Pollution Control Board (SPCB) deal with the implementation of these rules by developing procedures for proper management of rules formed by the MoEFCC.

India implemented the rules for e-waste collection since 2011 in the form of 'E-Waste Management and Handling Rules, 2011' which were superseded by new ones in 2016, i.e., 'E-Waste Management Rules, 2016' which heavily emphasised the Extended producer responsibility (EPR). There was a further amendment to those rules in 2018.

1. **E-Waste Management and Handling Rules, 2011:** These rules came into effect in May 2012. It stated that all manufacturers and importers of electronic goods were required to come up with a plan to manage their electronic waste. Producers or importers had to establish e-waste collection centres or employ take back systems. It also required the sellers of electronic goods to mandatorily provide consumers with information on how to properly dispose of the electronics to prevent people from dumping their electronics with domestic waste. The electronics companies who made products which classified as e-wastes, were also made responsible to make the consumer aware of the hazardous materials in their product. Furthermore, the commercial consumers and government departments were mandated to keep records of e-wastes and provide them to the state and federal pollution control boards.

2. **E-Waste Management Rules, 2016:** These superseded the 2011 rules and stated that the responsibility of effective e-waste management lies on the Central Pollution Control Board (CPCB), State Pollution Control Boards (SPCBs) and the Pollution Control Committees (PCCs) of the Union Territories (Ministry of Environment, Forest and Climate Change, 2016). These rules envisioned to formalise the collection and recycling of e-waste by holding brands responsible for its retrieval, and tasking state and central pollution control boards with monitoring the system[93]. The e-waste management rules, 2016 mandated the producers to establish proper collection and disposal of Waste Electronic and Electrical Equipment (WEEE) generated in India. It emphasised heavily on the extended producer responsibility (EPR).

3. **Amendment to the E-Waste Management Rules, 2018:** The 2018 amendment aimed to relax certain aspects of the 2016 e-waste management rules. It focused on the e-waste collection targets and set them for 10% during 2017-18, 20% during 2018-19, 30% during 2019-20 and so on. It also provided the CPCB power to randomly select electronic equipment on the market to test for compliance of rules. The government will be responsible for the financial cost associated with the testing. This responsibility was previously borne by the producer.

## Manpower requirement

Since the vast proportion – possibly upwards of 90% - of the manpower employed in e-waste management sector is in unorganized (and even non-enumerated) sector, there are no clear estimates of the total personnel employed in this sector. As per a report[94], more than 10 Lacs people in India are involved in manual recycling operations as of June 2020. A further 4.5 Lacs of direct jobs is estimated to be created by 2025[95].

[92] https://en.wikipedia.org/wiki/Electronic_waste_in_India
[93] https://theprint.in/environment/key-players-junked-scope-expanded-govts-proposed-e-waste-rules-worry-industry-insiders/1043283/
[94] https://www.downtoearth.org.in/blog/waste/how-e-waste-crisis-continues-to-plague-informal-sector-72033
[95] https://economictimes.indiatimes.com/jobs/e-waste-sector-will-create-half-million-jobs-in-india-by-2025-ifc/articleshow/68708339.cms?from=mdr

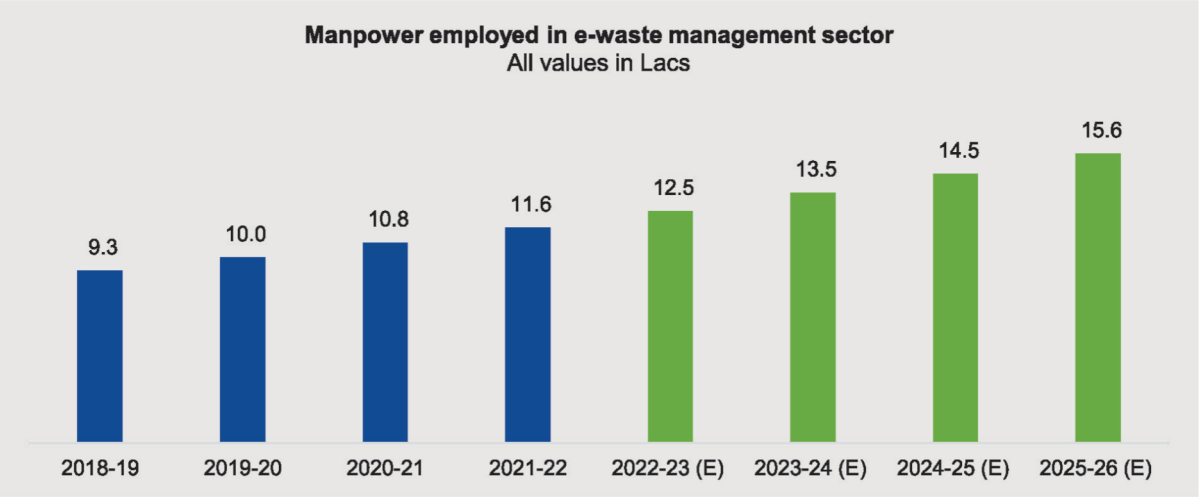



*Figure 97: Manpower employed in e-waste management sector (FY 2018 to FY 2025)*

These jobs would comprise of personnel, with various skills, required at various nodes of the value chain – right from collection to recycling. However, if we only consider the sole organized part of the industry, i.e., dismantling and recycling, there are no clear norms in terms of how many permanent employees a company may need basis its size of operations. The below selection of 15 e-waste dismantling and recycling companies with varying sizes (in terms of its size of operations or installed capacity) clearly show no direct relation of employee numbers with respect to size of operations.

*Figure 98: Select e-waste management companies in India along with their manpower and installed capacity*

| E-waste company | Installed Capacity (MMTA) | Employee Strength[96] |
|---|---|---|
| Adatte E Waste Management | 1,825 | 2 to 10 |
| E-Incarnation Recycling | 950 | 2 to 10 |
| Z Enviro Industries | 20,000 | 11 to 50 |
| Re-Teck | 2,500 | 11 to 50 |
| E Waste Recyclers India (EWRI) | 667 | 11 to 50 |
| GreenWaves - Recyclers | 480 | 11 to 50 |
| ViroGreen | 15,000 | 51 to 200 |
| EcoReco (Eco Recycling Limited) | 7,200 | 51 to 200 |
| Namo E Waste Management | 5,796 | 51 to 200 |
| ECS Environment | 5,000 | 51 to 200 |
| Evergreen Recyclekaro | 2,400 | 51 to 200 |
| Cerebra Integrated Technologies / Cerebra Green | 2,076 | 51 to 200 |
| Green Recycling | 303 | 51 to 200 |
| Attero / Attero Recycling Pvt Ltd | 1,44,000 | 201 to 500 |
| Exigo Recycling | 6,000 | 201 to 500 |
| **Average (Installed Capacity / Person)** | **Approximately 125 MMTA Per Person** | |

The above companies, cumulatively, account for more than 15% of the total installed capacity. Considering them to be representative of all the dismantlers & recyclers, the total manpower employed at the last mile – i.e., with dismantlers & recyclers – could be in the range of 10-15,000.

*96 Source: LinkedIn*

# Major job roles, required skills and upskilling practices

## Major job roles and skills

As discussed above, most of e-waste management value chain is highly unorganized and comprised mostly of unskilled workers – especially at the collection and segregation nodes. However, the dismantling & recycling end of the value chain also comprises of some white-collar employees to look after the more technical aspects of the process.

> We have offices and units at many places. For e.g., in our Greater Noida plant we have 150 labour work force and 15 office staff. In our Panipat centre, we have about 200 employees, out of which 50 is office staff.
>
> – **E-waste recycling company**

E-waste management companies mostly have the following job roles which define their work:

1. **Collection executives:** While e-waste collection from end-users remains, largely, a highly unorganized business, even the recycling companies have their own collection teams who collect/buy e-waste from the primary collectors. These collection executives require a thorough understanding of electronics and electrical products so as to be able to evaluate right price to purchase the same.

> *The collection team should now about the contents and components in an electronic waste, what metals are to be found, what could be the value. Different products and SKUs have different value in terms of e-waste. A collection executive should be knowledgeable on these aspects. This knowledge only comes from practical experience. A person has to be a smart learner.*
>
> – **E-waste recycling company**

> "So first of all on the collection part, we have teams that visit different places, they search online, offline, and they find out what is the type of waste, what is its category, what is the quantity, and then accordingly we arrange logistics. So while arranging for the logistics, we should know the dimensions of the vehicle, how much waste can it accommodate, how much time would be consumed in terms of loading and unloading, transportation.
>
> – **E-waste management company**

2. **Marketing/business development:** Business development team is responsible for developing business relationships with major OEMs in electronics and electric product categories as their e-waste recycling partner.
   - For e.g., Attero Recycling, which is one of the largest e-waste management companies in India, has amongst its client electronics/electrical majors such as Koryo, B/S/H, Godrej Appliances, Whirlpool, LG, Acer, MG, boAt, Zebronics, Oppo etc.

> *Now if we look at EPR category – i.e., extended producer responsibility – we have to do tie-ups with OEM, bulk producers or consumers. It is here from where we get our waste. We come to know of the availability of such waste through tenders.*
>
> – **E-waste recycling company**

3. **Operations and/or production**: Manpower in these roles are responsible for overseeing dismantling and recycling operations as per the prescribed procedures. Within this domain, there are shopfloor level jobs as well as white collared jobs.

   — Shopfloor level jobs include workers and supervisors who are mostly involved in segregation process and operating machines. The key skills required by them is to have visual understanding of various electronic products and their components. In addition, they need to be able to operate machine efficiently. No specific education is required.

> *Material handling is critical in this job. They need to know how to handle a monitor, how to handle a motherboard, how to handle a RAM and so on. A supervisor's role in case of segregation is to ensure that the segregation process is uniform and that there is no mixing up. Otherwise the hard work needs to be repeated.*
>
> **– E-waste recycling company**

> *The machine operator – let's say compressing unit operator – just has to operate some switches. No experience is required – they learn on the job. When a new employee joins us, we send him to a senior employee for training*
>
> **– E-waste recycling company**

   — In case of white-collared or managerial jobs in operations domain, key skills required include the following:
      — Understanding of quality norms & standards at various steps of dismantling & recycling. These include integrated water resources management (IWRM), integrated solid waste management (ISWM), environment, health & safety (EH&S) management, global e-waste management systems, pollution control policies, etc.
      — Operation of machines used in dismantling & recycling. For e.g., incinerators.
      — Understanding of all other aspects related to e-waste management such as SPC review, DRB completion, audit support, supplier quality management, complaint investigation etc.

> *We need manpower that has an understanding of electronic waste. So initially we train them, we tell them what is electronic waste and how it is handled, from where they have to pick particular components.*
>
> **– E-waste recycling company**

> *So let's say we have to compress that waste in the compressing unit. We need an operator to operate this compressing unit. Now these operators can be ITI qualified, otherwise generally we train them for one or two days. The compressing unit has four or five basic operations where one has to learn how to work on hydraulics. On an operator level, not much skill sets are required. The only thing is that the understanding should be good depending upon which instrument are you dealing with. Because as far as I have observed in the case of an operator, experience matters the most.*
>
> **– E-waste recycling company**

— A key challenge which e-waste management companies face is lack of availability of a pool of skilled white-collared or technical personnel. This is a new industry and there are very few people who are trained in e-waste management. In addition, the requirements of the industry too keep changing as the technologies evolve.

> "We had a Plant Manager earlier who was a chemical engineer. But the thing is this is a very new industry and we don't have a lot of people who have the background of this industry. We need people with B.Tech. or M.Tech. in branches such as chemical engineering, hydro-metallurgical engineering etc. People with. Technology background are good because they would, at least, have some knowledge in engineering. The industry itself is very dynamic – everyday we deal with something new."
>
> **– E-waste recycling company**

4. **Sales/after-sales:** This team is responsible for forming business relationships and sales activities for recycled materials for reuse.

In view of key stakeholders in the e-waste management industry, the skill set required for the industry is not going to undergo a marked change due to, largely, unskilled nature of workforce that is required. At the same time, there are a few developments which may impact the way the industry works.

Some of these include:

1. **Artificial Intelligence (AI)/Machine Learning (ML):** These new data analysis technologies can help evaluate the components in e-waste as well as ideal pricing for a product. These may also be able to advise regarding the areas which are likely to produce more e-waste basis sales and human behaviour data. This would increase operation efficiencies of an e-waste management company.

2. **Recycling technology:** Changes in recycling technology – especially with regards to plastics which form bulk of an electronic item's weight – may prove to be a game-changer. New technology may make the process of recycling cheaper while making them more efficient leading to better profitability.

3. **Carbon trading specialist:** Since e-waste management has the potential to generate carbon credits which can be traded in the carbon markets, a carbon trading specialist role may become important in the future.

## Upskilling practices by employees

Employees in various companies operating in e-waste management sector actively strive to keep themselves upskilled in order to remain relevant in the ever-changing job market. However, they face multiple challenges to remain upskilled. The most common challenge faced by them is lack of time. Other major challenges include lack of funds as well as lack of training resources – both within organization and outside it.

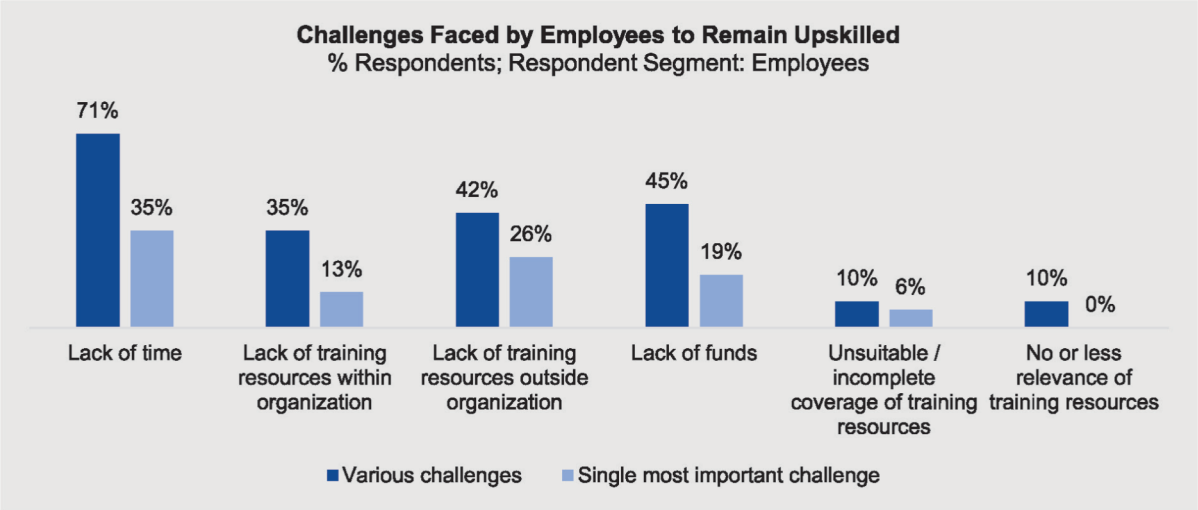



*Figure 99: Challenges faced by employees to remain upskilled (e-waste/circularity)*

> There is no subject, no methodology for e-waste management in any institution. It is not taught as a syllabus. There might be just one or two chapters. This should be a dedicated course with clear instructions on usage of various types of machines.
>
> **– E-waste recycling company**

E-waste management is a very practical field and the more than 50% of employees receive training through on-job instruction as well as industry visits. Very few employees are provided online or classroom-based training by their company.

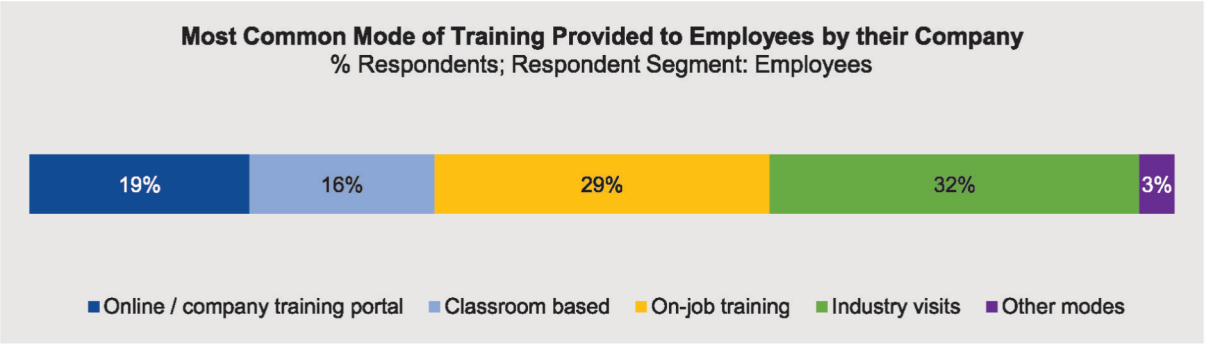



*Figure 100: Common modes of training provided to employees by companies (hearables & wearables)*

> In classroom training, employees don't understand what they are being trained for. Suppose I am telling you about a circuit, you can't understand what it looks like and what type of circuit it is – radio or tape or computer. But if you hold it in hand, you will know it instantly."
>
> **– E-waste recycling company**

Most employees not only find the coverage of course curriculum, of in-house training, adequate but also relevant for increasing their efficiency and efficacy in their jobs.

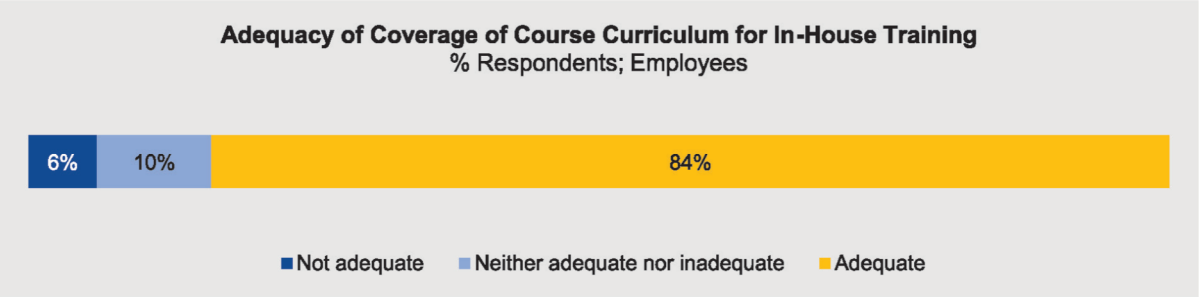



*Figure 101: Adequacy of coverage of course curriculum for in-house training (e-waste/circularity)*

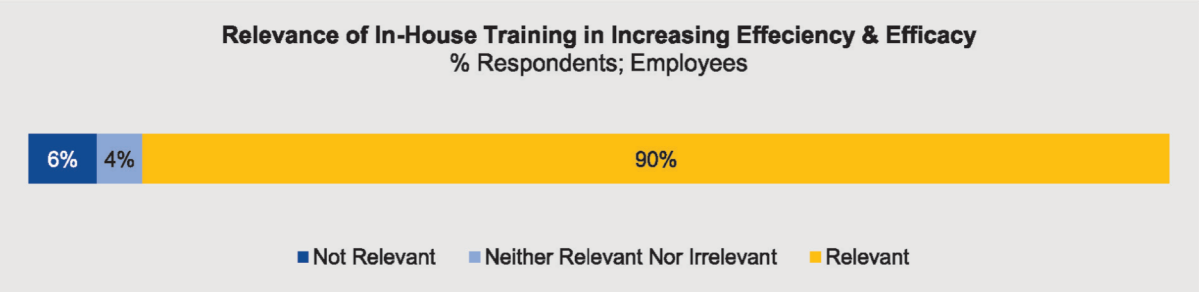



*Figure 102: Relevance of in-house training in increasing efficiency & efficacy of employees (e-waste/circularity)*

Apart from being trained by their company, many of these employees also use external sources of training – most commonly being online/MOOC courses available on Coursera, Unacademy, eDX etc. – to remain upskilled. Many of them also taken for industry visits by their companies (or, rarely, on self-initiative).

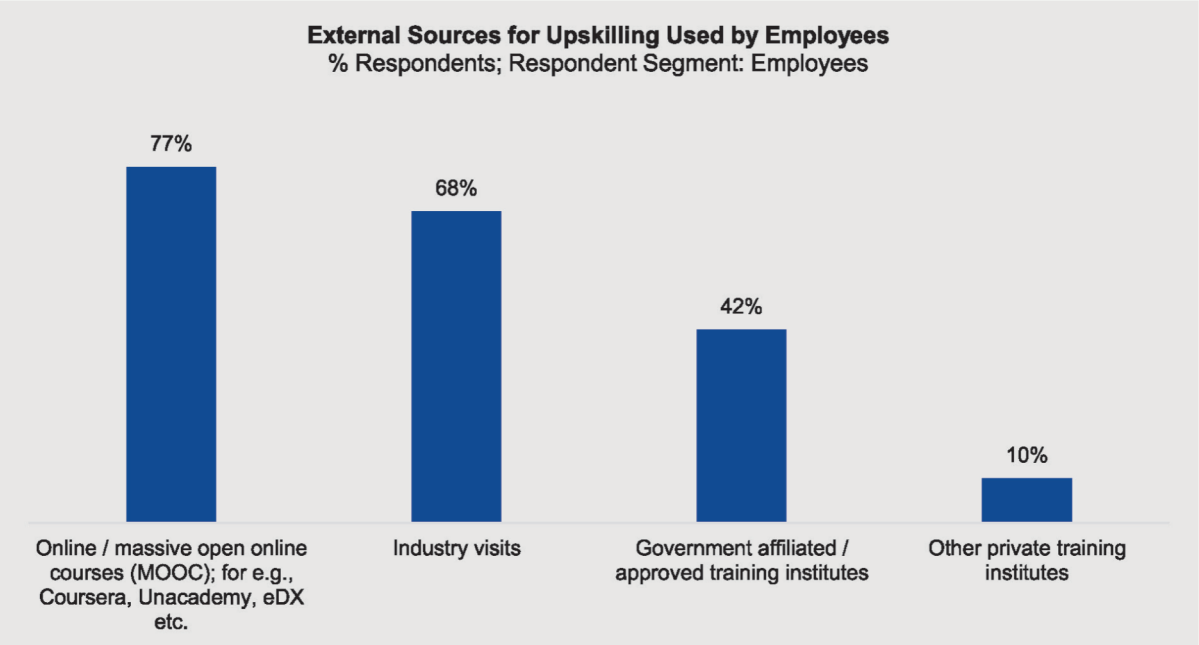



*Figure 103:External sources of training used by employees for upskilling (e-waste/circularity)*

Industry visits, followed by government approved training institutes, are generally considered the best in terms of their coverage of training material. They do not find coverage of course curriculum to be so good in private training institutes.

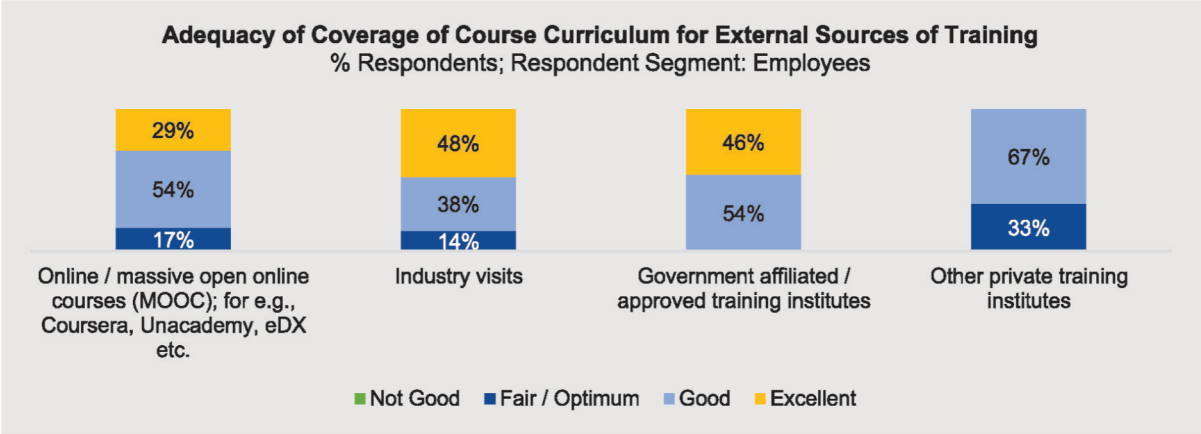



*Figure 104: Adequacy of coverage of course curriculum for external training (e-waste/circularity)*

Training and experience provided by industry visits are also considered among the best for increasing efficiency and efficacy of their jobs.

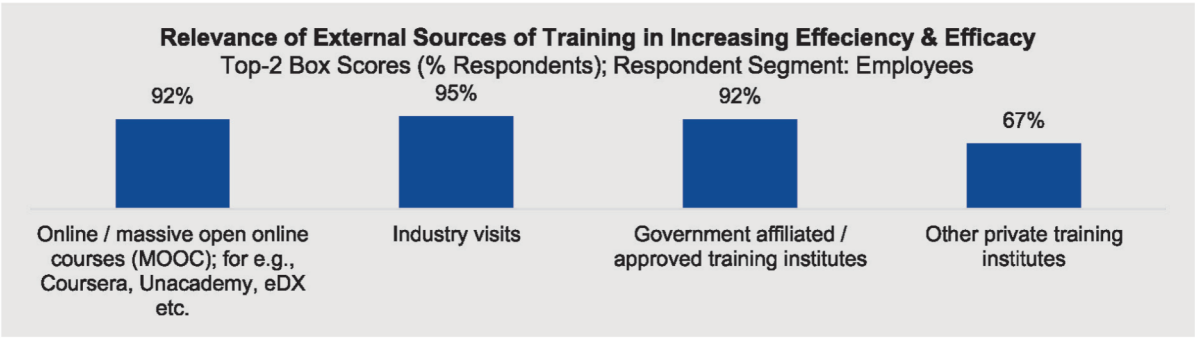
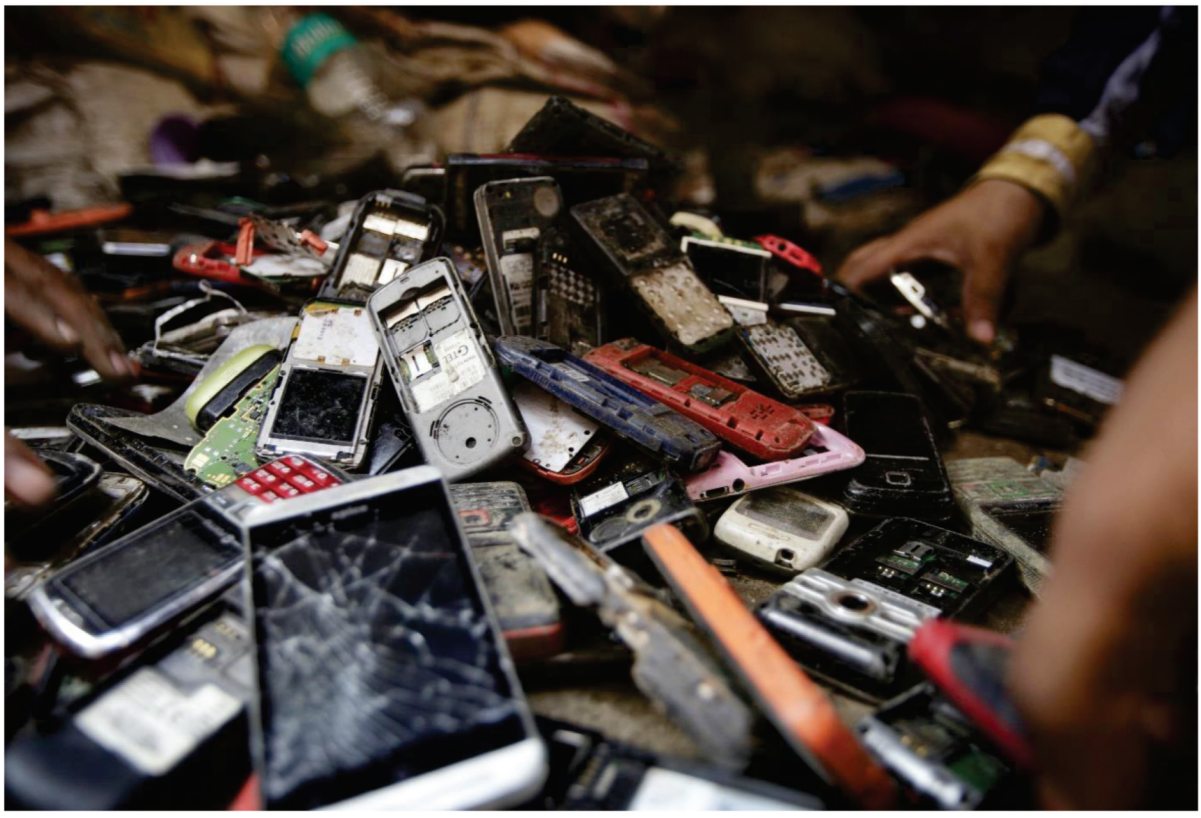



*Figure 105: Relevance of external training in increasing efficiency & efficacy of employees (e-waste/circularity)*



# Conclusion

Electronics market in India is estimated to be around US$ 340 billion in the year 2021-22. Of this market, less than 50% is contributed to by domestic production while a bulk is catered to by imports. The primary push towards the growth of electronics sector in India would come from policy push which aims to make India a manufacturing hub for electronics. Not only would growth in electronics sector in India contribute to foreign exchange earnings through exports but would also provide a spur to employment generation in the country. However, in order to truly make India a global electronics manufacturing hub, a skilled workforce is of utmost priority.

Table below gives the market size, in US$ billion, in 2021-22 and its projections till 2025-26 for sub-sectors such as semiconductors and components, electronics manufacturing services and hearables & wearables. It also gives total e-waste generated, and its projections, in million metric tonnes (MMT).

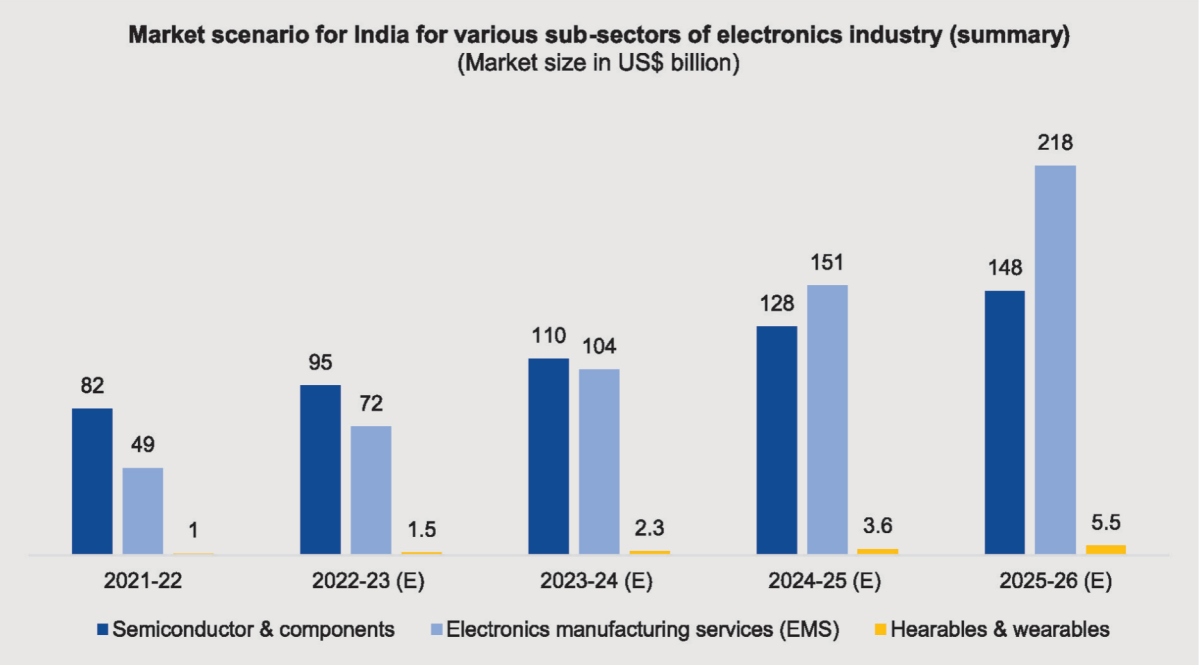



*Figure 106: Market scenario for India for various sub-sectors of electronics industry (summary)*

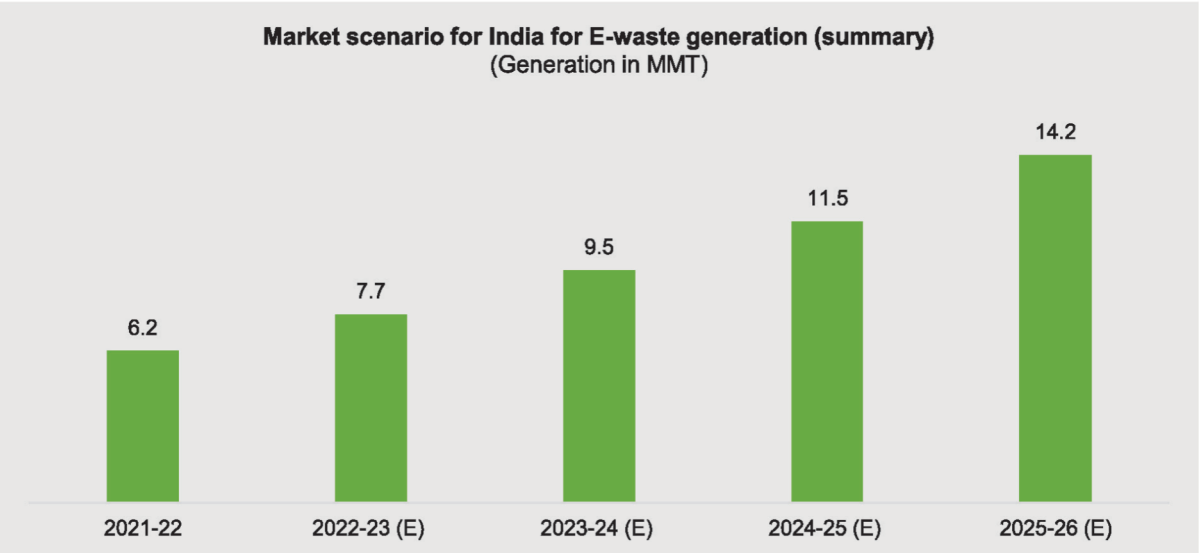



*Figure 107: Market scenario for India for E-waste generation (summary)*

Table below gives manpower employed in these four sub-sectors currently, i.e., in 2021-22, and its projections till 2025-26.

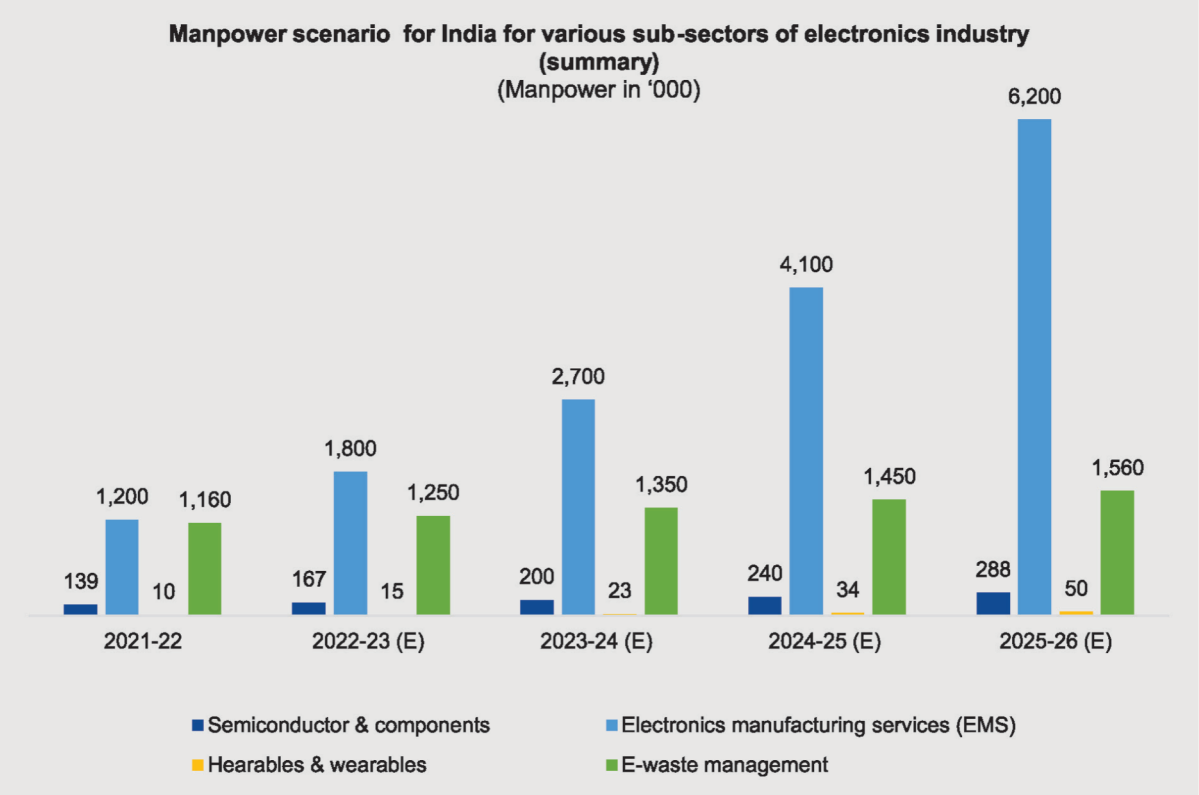



*Figure 108: Manpower scenario for India for various sub-sectors of electronics industry (summary)*

The highest number of manpower is currently employed in electronics manufacturing services and e-waste management sectors. However, not only is the manpower employed in EMS sector skilled workforce, it also has the highest growth potential in future.

**Basis the findings of the study, we would recommend the following to ESSCI:**

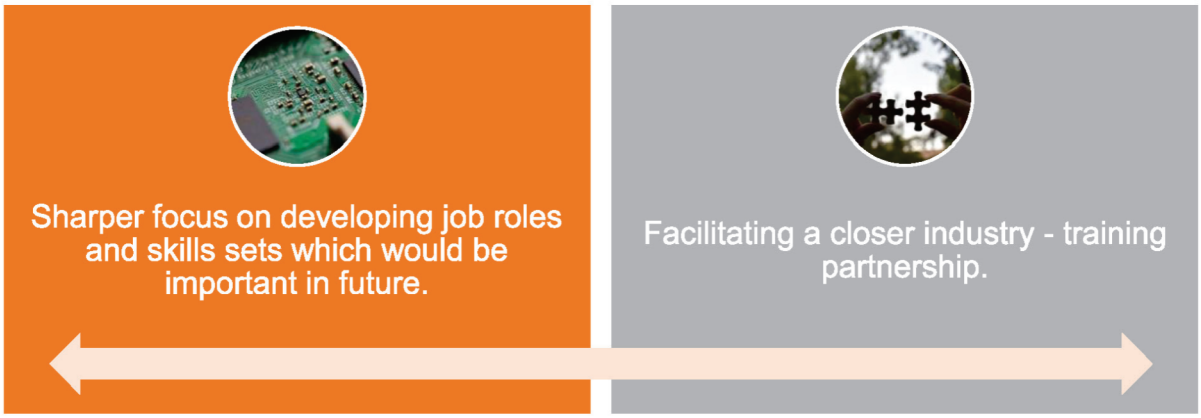



*Figure 109: Key recommendations for ESSCI basis research findings*

**Sharper focus on developing job roles and skills sets which would be important in future**

Kantar analysis has classified major job roles into medium and high priority for future in terms of their expected importance in future. These are listed below:

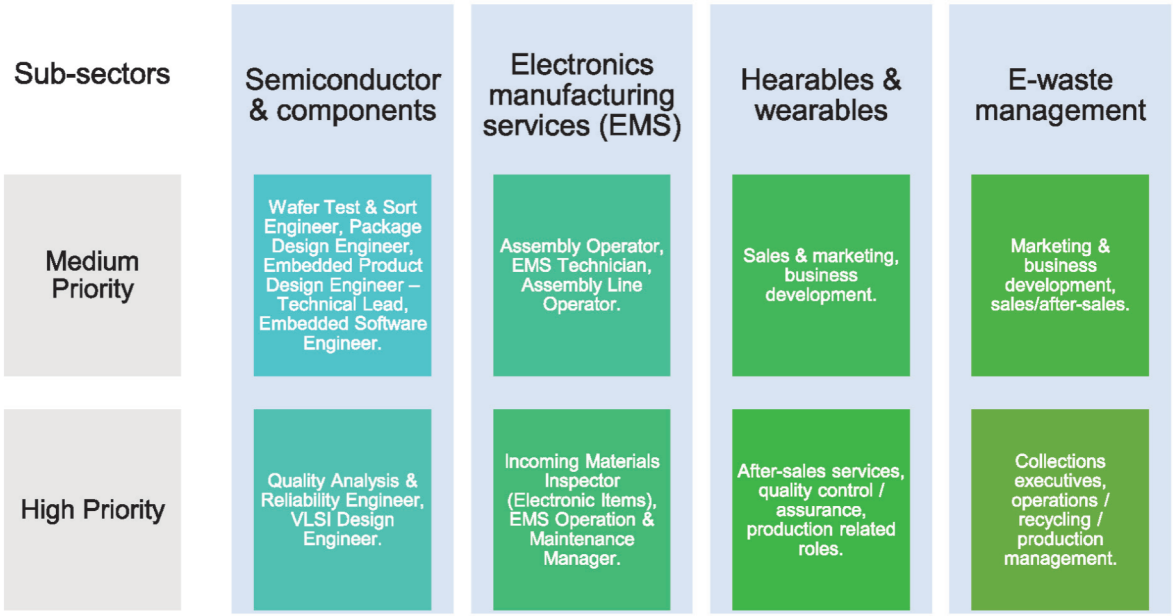



*Figure 110: Job roles in importance of priority for future for various sub-sectors*

Key skills that these job roles would require would include technical knowledge of computer hardware and software systems, technical knowledge of electronics and electrical systems, knowledge of circuit design, knowledge of information technology & information systems and knowledge of testing for sectors such as semiconductor and components, EMS and wearables & hearables. For the e-waste sector, key skills would be knowledge of recycling technology, understanding of quality norms & standards at various steps of dismantling & recycling, operation of machines used in dismantling & recycling, SPC review, DRB completion, audit support, supplier quality management, complaint investigation.

ESSCI needs to focus on high priority jobs as listed above as well as the skill sets in its future strategy. It should develop an industry acceptable course structure for these job-roles – with both theoretical and practical components – in close consultation with major companies in the industry. This would make these job roles future ready armed with necessary skillsets.

**Facilitating a closer industry - training partnership**

Very few companies in the study sectors are of the opinion that their newly hired employees are fully job-ready who require no training. In fact, most feel that while they are somewhat ready but do require some training. While these companies provide in-house training to their employees, the general view is that the industry's growth would be faster if trained employees are available on the job market. This is possible via external training institutes which can train students to become ready for the job market. While the companies, at an overall level, are satisfied with the quality of labs & equipment at these institutes as well as their level of industrial collaboration, there are some need gaps around training cost, quality of instructors/trainers as well as training efficacy for job readiness. There is an almost uniform view in the industry that a closer collaboration of major companies in the sector with training institutes, and even higher educational institutes is critical for producing a ready stream of well-trained prospective employees.

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