INDIAsize- Planning & Execution of National Sizing Survey of India

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Abstract

Research studies conducted on fit and human-body measurements across the globe indicates that a large percentage of consumers face difficulty in finding clothes that fit them perfectly according to their body shapes and sizes. The overarching reason is differences in anthropometric built of people from one region to another. This has led countries to undertake national sizing surveys to create anthropometric database of measurements which is a true representation of the entire population, to cater to their respective retail industry. The size charts and insights generated through these surveys and corresponding analysis has helped the garment industry to provide well-fitting garments designed as per the body structure of the native population. India is facing the same dilemma. The Indian apparel industry uses size charts which are largely tweaked versions of size charts of other countries and are created more out of the manufacturer's instinct and experience than a proven scientific study, resulting in fits which leave lot to desire. Projected returns of the garments are in the range of 30% to 40% (and is increasing with the growth of ecommerce) and the major reason for the returns are poor garment fit. Providing well-fitting garments in the absence of standardized size chart is proving to be a big challenge for the domestic textile and apparel industry in India Hence, India is undertaking its own anthropometric survey-INDIAsize, to develop standard body sizes for Indian apparel sector to address the prevailing disparities and inconsistencies in apparel sizing systems and provided fits. INDIAsize targets at collecting anthropometric data from representative Indian population, of youth, adult and elderly, calculated basis stratified sampling of Census data of India. Data is being collected from various demographics of age, region, sex, income and community (rural &urban) using non-contact, human safe 3D whole body scanning technology. More than 25000 (Twenty-Five Thousand) male and female persons between the age group of 15 years and 65 years are being scanned in six major cities located in six regions of India i.e., New Delhi (North Region), Chennai (South Region), Kolkata (East Region), Mumbai (West Region), Hyderabad (Central Region), and Shillong (North-East Region). The anthropometric data on more than 120 anthropometric points are being extracted in two postures i.e., Sitting and standing from the participants of the survey. The survey is guided by various ISO protocols of 8559, 7250, 20685 etc. The survey will create Size identification number for a customer through mapping, categorization and defining of their body shape and size. This indigenous body size chart thus created will help national and international retailers and manufacturers to produce goods which are best suited for Indian body types and create a balance between demand and supply of well fitted clothes. The paper shares the details of planning this large-scale survey and data collected so far.

Keywords: Sizing survey, 3D body scanning, body size chart, anthropometric data, apparel

1. Introduction

Research studies on fit and human-body measurements conducted across the globe indicate that a large percentage of shopper's face difficulty in finding clothes that fit perfectly according to their body measurements. The overarching reason is differences in anthropometric built of people in different geographical regions of the world and even across the country. This has led countries to undertake national sizing surveys to create anthropometric database of measurements, which is a true representation of their population, to cater to their respective retail industry. The size charts and insights generated through these surveys and corresponding analysis has not only helped them to provide well-fitting garments but also to produce ergonomically designed products which are well suited for the body structure of the native population.

1.1. International context

Till date, more than nineteen countries across the world have undertaken and successfully completed national sizing surveys like USA, Mexico, UK, France, Spain, Germany, Sweden, Italy, Netherlands, Thailand, Korea, China, Australia, Austria, Belgium, Singapore, Taiwan, Finland, etc. Many of the countries have revisited / revised their original size charts to accommodate the changes in body dimensions over time. The standards thus developed by these countries like ASTM (USA), GB/T(China),

JIS (Japan), KS (South Korea), AS (Australia), EN (Europe), AFNOR (France) etc. are used to create products for their own population nationally and globally. These standards have been time and again updated by undertaking the sizing surveys again to validate /change the finding of the past surveys to keep them relevant and effective.

These national sizing surveys are undertaken by collecting anthropometric data through measuring statistically justified sample population and analyzing to create a standardized database of measurements, i.e., Size chart, which is a true representative of the entire nation. These surveys were earlier undertaken, in manual mode by using anthropometric tools to extract measurements of a person, this process was time consuming, inaccurate and uncomfortable some such surveys undertaken are for US (1921,1937),Finland (1988), Spain (1967), Austria (1976), Belgium (1990) etc. Over past almost two decades (since 1998) sizing surveys have been typically undertaken with use of state-of -art 3D whole body scanning technology. The 3D whole body scanners are non-contact method of extracting body measurements that captures accurate 3D body maps in less than 10 seconds in one posture. It scans the body and creates a point cloud from where hundreds of body measurements are extracted automatically through computer programming eliminating manual measurement and transcription errors. This non-contact technology is quick, consistent and human safe and helps immensely reduce the time frame of the anthropometric surveys. It has been employed in all the national sizing anthropometric surveys undertaken in recent years by many countries. First sizing survey conducted using 3D body scanner was during 1992 by Japan followed by CAESAR in 1998, where 4431 subjects between 18-61 years from 3 countries were measured[1]. The first comprehensive sizing survey using 3D body scanner with the prime objective of developing body measurement charts to facilitate garment retailers, was carried out by a consortium of UK Government, fashion retailers, academia and technology companies in the years 1999-2002[1]. Summary of some of the sizing surveys undertaken by countries i.e., sample size, postures in which the scanning was undertaken, measurement points and scanning technology used etc. is in Table 1[2]. In addition to the surveys mentioned in Table 1 countries like Singapore, Taiwan, Brazil, South Africa has also conducted National sizing survey. Size North America is last of the survey undertaken. There are some private organizations, that have conducted 3D body scanning in some countries[4] and developed size charts based on body measurement and garment fit which were limited to individual retailers or clients.

TABLE 1- Summary of some of the sizing surveys undertaken by countries

Country	UK	UK	USA	Australia	France	Mexico	Thailand	China	China	USA	Netherland	Greece	Italy	Sweden	Germany[3]
Project	Size UK	Shape GB The National Children wear Survey	Size USA	Sizing Survey	Sizing Survey	A Sizing Study of the Population of Mexico	Thailand's National Anthropometrics Database	Sizing survey	-3D data base for head &face shapes	CAESAR -	Swedish anthropometrics for product and workplace design	-			SizeGERMANY
Year	2002	2011	2003	2004	2005	2012	2006	2006	2006	2000	2000	2000	2002	2006	2008
Age	16-90	4 -17		18-70	5 - 70	18-65	16-90	4 - 17		18-65	18-65	-	18-65	18-65	6-65
Sample Size	11000 female and male	2500 Boys and girls	10500 female and male	1330 female and 135 males=1465	11560 female and male	16,000	13,442	20,000	2,500	2400 female and male	1200 female and male	2000 male female children	1500 female and male	4000	12000
Scanner	TC2	TC2	TC2	TC2 & laser -Cyberware and Vitronic	Vitrus Smart Human solutions	TC2	TC2	Human Solution	Cyberware	Cyber ware WB4	Vitrus Pro			Vitrus Smart Human solutions	Vitrus Smart Human solutions
Scan Data	Body Excluding Hand Feet and Head	Body Excluding Hand Feet and Head	Body Excluding Hand Feet and Head		Full Body		Body Excluding Hand Feet and Head		3d Head-And-Face Scanner	Full Body	Full Body	Full Body	Full Body	Full Body	Full Body
Stances	Standing and sitting	Standing and sitting	Standing and sitting		Standing and sitting		Standing and sitting		face and head	Standing and sitting	Standing and sitting	-	Standing and sitting	Standing and sitting	Standing and sitting
Measurement Points	130 automatic + 10 manual = Total 140		200	54	55 automatic + 10 manual =65		140			60+ automatic & 40+ manual= more than 100	82 automatic +40 manual=124	22	60 automatic +40 manual= 100	43	80 scanned

1.2. Indian Context

The oldest record of anthropometric data for Indian population was based on racial typology Risley, Eikckstedt, and B.S. Guha. Between 1949 to 1981[5] there were several studies based on interregional framework. Anthropological Survey of India has undertaken three large-scale anthropometric surveys during 1963, 1969 and 1985[6]. However, the measurements taken during the above anthropological studies were quite different from those required for the purpose of developing size charts for the garment industry and hence were not really helpful.

Additionally traditionally Indians have used only draped garments where 'one size fitted all' therefore, the concept of 'stitched to fit a body' was not part of the culture and if at all there was a need of sewing, it was catered to by the local tailors. Therefore in the past India did not feel the need for ready-made garments. But now the clothing preferences has shifted from traditional draped garments to stitched and body fitted clothes, also there is a shift from wearing only Indian wear to western or Indo-western wear. This shift of preference, demands clothes to be mass-produced as per the Indian body size and hence the need of Indian body size chart. Lack of existence of the same, the Indian apparel industry has been using American and European/ British body size measurements which often translates into ill-fitting clothes.[7] Currently size charts from these countries are 'adapted'/ 'tweaked' based on the manufacturers 'instinct' and 'experience' to formulate a size chart for their own brand[8] Since each brand has its own understanding and sensibilities regarding Indian anthropometric built and they have their own body sizes and sizing labels, which are different from the other brands. As a result Indian apparel retailers have various size labels each indicating different interpretation of Indian anthropometric make. These attempts on estimation of India body size chart often translates into ill-fitting clothes and confused consumers about the 'suitable' apparel size for them. Result of all these size development strategies is a 'dissatisfied' consumer and massive merchandise returns. In addition to the losses incurred by the return of the merchandise there is loss of sales because of non-availability of desired size and proper fit. So it can be said that lack of accurate anthropometric data and resulting Indian size chart is leading to Indian apparel industry inefficiency in providing good fitting garments, lost business opportunity, and consumer frustration. Projected returns of the garments are in range of 25% to 40%[9] (and is increasing with growth of e-commerce), which are staggering and major reason for the returns are said to be poor garment fit. [10]

Study on "Garment Sector to understand their requirement for Capacity building" January 2018 MoT (Technopak) Annexure–17[7] The Need of garment sizing states that with unprecedented retail growth and 'fit' being the major criteria for purchase, need for having a systematic and scientific system for measuring and classifying human bodies in India for the purpose of developing a sizing system for garments is becoming more and more acute. It is not that there were no anthropometric studies undertaken in India at-all in the past but these studies were undertaken with primary focus on ergonomic work place, tool or machinery design for automobiles, agriculture, furniture etc. For example studies were undertaken by NID[11], DRDO[12,] Institute of Aerospace Medicine[13] ISI, Society of Ergonomics and Anthropological Survey of India[14], IIT[15] and CIAE[16] but the generated data was not useful for the purpose of developing size charts for the ready to wear garment. Further, Small size survey for ready to wear garment making industry was also conducted by institutes like NIFT(as part of student research) and IIT[17] and some retail brands but these studies were conducted specific to region/area or for specific commercial client hence sample size was small and not representative of pan-Indian population. The Automotive Research Association of India (ARAI) undertook the most recent survey in 2010, wherein 4890 subjects were measured, but the study was to cater to the automotive industry[18]. Though many anthropometric studies have been undertaken but none of them were sufficient to create apparel size chart.

With Indian domestic textile and apparel market estimated to grow at 10% CAGR from 2019-20 to reach US$ 190 billion by 2025-26 and exports are expected to grow to US$ 65 billion by 2025-26 growing at a CAGR of 11% wherein apparel constitutes ~73% share of the total T&A market in India it is paramount to address the issue of apparel returns and loss of sales[19].

Vision, Strategy And Action Plan For Indian Textile And Apparel Sector- July 2015- Clause 3.6.5 establishes the need for undertaking the National sizing survey of India by stating *'Despite being one of the largest consumer markets in the world, there is no standard apparel sizing system in the country specific to Indian consumers. Apparel in the Indian market displays either European or American size. These naturally do not conform fully to the body sizes of Indians. Providing right size and fit will foster the growth of ready-made garment industry in the country. Hence, it is recommended that a scientific, systematic anthropometric study of Indian population should be undertaken for developing a standard Indian sizing system.*'[20]

2. Research gap, objective and target

RESEARCH GAP -With apparel sales in India expected to reach $75.2b in 2022 [21], and $10.5b in 2025[22] and returns as high as 25-45% Due to fit issues resulting from lack of anthropometric data the need of undertaking of national sizing survey is blatant. National sizing survey of India-INDIAsize, was undertaken to address this research gap

OBJECTIVE OF THE STUDY-'INDIAsize' is a scientific research aimed to improve understanding of anthropometry of Indian population to support ergonomic driven work environment & products. It is an exercise where anthropometric data is collected from a statistically justified sample Indian population to create a database of measurements which is a true representative of the entire nation.

TARGET OF THE STUDY-The projects primarily focus on apparel sector to take care of disparities and inconsistencies in apparel sizing and provided fits although the anthropometric data may be used by other industries working in area of Work place Ergonomics & Product design companies to make functional design, Arts & social sciences for art and sculpture, animation, computer games etc. and Fitness & Sports fitness etc. to improve the products and procedures

3. Methodology

Sizing surveys broadly require planning and preparation for data collection, actual data collection, data analysis and creation of sizing system. INDIAsize study was undertaken as per the following methodology (Fig 1)

3.1. Step 1 Field work Preparation

This is a planning stage which involves fine tuning of various processes, stages and steps which defines and aids the actual survey
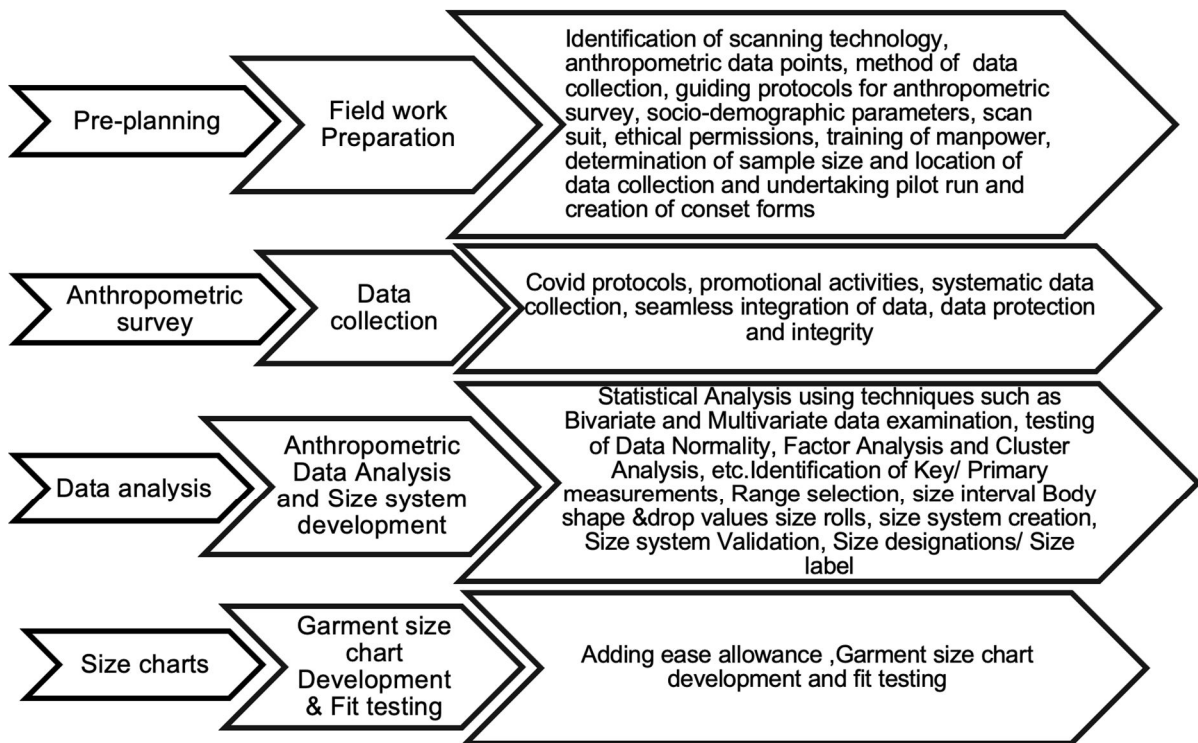

Fig 1- INDIAsize Methodology

3.1.1. Identification of scanning technology

It is a key consideration to identify the 3D Scanning technology, which will be used to undertake the survey. Currently four major technologies are commercially available in 3D whole body scanning and extraction of body measurements- laser scanning, white light projection, millimeter wave and depth sensor technology. The white light and laser technology have been predominantly used for national size surveys over the years for creation of size chart. Depth sensor technology is the newest in the field. For INDIAsize various parameters were compared to identify the scanner, which met the need of the project and the involved stake holders. There were three scanners procured of depth sensing technology for INDIAsize study. Some of the parameters used for INDIAsize for selection of technology

for apparel sizing surveys were-Number of angles and Sensors, Surface data density, Scan area /scan volume, Body coverage, Measurement Accuracy ,Scan time Compliance with norms in ISO standards, Stool for scanning in sitting posture, Superior crotch point detection, Scan safety, Option of slicing the avatar, Flexibility to Configure user defined measurements.

3.1.2. Identification of anthropometric data points

The selection of the anthropometric measurements is in accordance with the target industry. Typically ISO 8559-1:2017[26] and /or 7250-1:2017[26] are the preferred protocols for selection of the anthropometric data points. The former ISO protocol is specifically for clothing while latter is for technological design. ISO 8559-1:2017[25] has 122 measurements while 7250-1:2017[26] has 62. There are 25 measurements overlapping between the two protocols. Additionally new set of measurements can be defined depending upon the need and focus of the survey.

For INDIAsize 121 anthropometric measurements are being considered from ISO 8559, 7250 and NIFT defined measurements which comprise of

- Vertical measurements-23
- Breadths, widths and depths- 13
- Arc - width / arc of the body-05
- Girth measurements-33
- Distances measured following the surface of the body-32
- Hand and foot measurements-05
- Other measurments-02
- Calculated measurments-07

3.1.3. Identification of method of anthropometric data collection

This is a key consideration to identify the posture in which the scanning needs to be undertaken as per the kind of data required. ISO 20685:2010-11[23] subscribes following four postures in *Fig 2* and scanning can be undertaken in all or some of the postures below. The list of desired measurement points have to be matched against the best posture to extract the measurement. For INDIAsize standing posture A and Sitting posture (which was combination of posture C & D) were used which reduced the scanning time whilst gave all the desired measurements. Postures of data collection is captured in *Fig 3.* Table 2 lists the posture in which the measurements were extracted for INDIAsize.
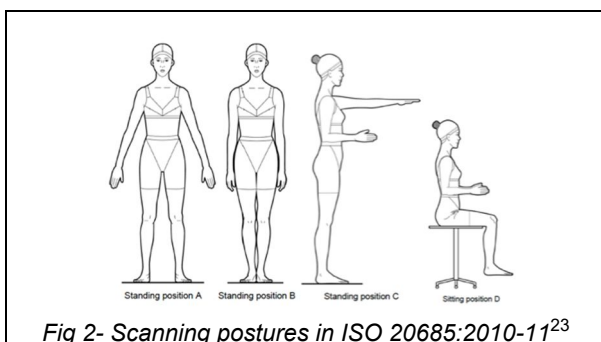

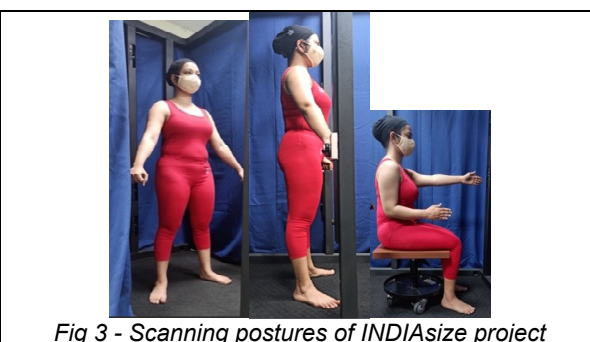| *Fig 2- Scanning postures in ISO 20685:2010-11*[23] | *Fig 3 - Scanning postures of INDIAsize project* |

3.1.4. Identification of guiding protocols for anthropometric survey

The anthropometric studies undertaken in recent past utilizes various ISO standards developed for the purpose

some of the ISO protocols which governed the INDIAsize sizing survey is as follows

- ISO 20685: 2010-11- International standard for 3D scanning methodologies for international compatible anthropometric data bases for protocol for 3-D
- ISO 20685-2:2015(E) - Evaluation protocol of surface shape and repeatability of relative landmark position
- ISO 8559-1:2017 Size designation of clothes- Anthropometric definitions for body measurement
- ISO 8559-2: 2017, Size designation of clothes — Part 2: Primary and secondary dimension indicators
- ISO 8559-3: 2018, Size designation of clothes — Part 3: Methodology of the creation of the body measurement tables and intervals
- ISO 7250-1:2017 Basic human body measurements for technological design -Part 1:Body measurement definitions and landmarks
- ISO 15535:2012(E)[27] General requirements for establishing anthropometric databases

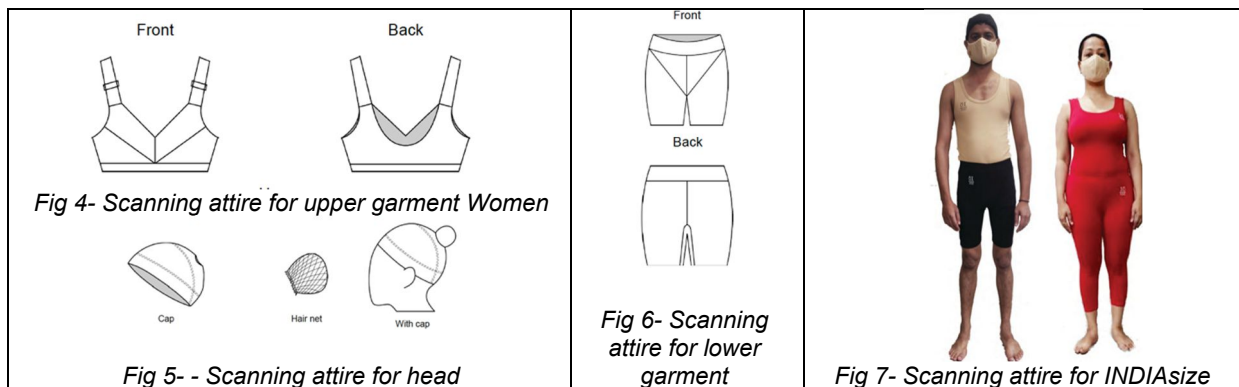### 3.1.5. Identification of socio-demographic parameters

As per ISO 15535[27] background information (such as sex, dwelling or working place, occupation, education) used to describe members of the user population and/or population segments could be used for sample size determination . For INDIAsize five main demographics which were considered were age, sex, economic status, region and community (rural or urban). Apart from those other demographic variables that influence anthropometric distributions like employment, job, education, lifestyle etc. are also considered to study impact on body structure of the individual.

3.1.6. Selection of Scanning attire

As per ISO 20685:2010-11[16] the scanning attire should be minimal, within the bounds of modesty keeping in mind the cultural constrains. Men and women attire with head gears as in ISO is in fig 4,5&6 Usually all the scanning surveys have measured the men and women in a undergarments but keeping Indian cultural constrains in mind special scanning attire was designed and tested. This scan suit designed for the purpose was with more body coverage. For women scanning suit was a above hip length top with thin shoulder straps and deep neckline with full length egging. For men vest and cycling shorts were designed. The designed scan suit were form fitting, so that there were no looseness or folds as it will add dimensions to the measurements. At the same time it was not compressing the flesh, as that will cause reduction in the body dimension. The texture and color were compatible with the scanner. The skinsuits were tested for comfort of wearer, scanning accuracy, fabric appropriateness and suitability for scanning. Scan suit for INDIAsize is captured in Fig 7- Women with top, Legging, mask, cap and brassier and Men with vest cycling shorts cap and mask.

3.1.7. Ethical Permissions

The study involving human subjects requires mandatory clearance from the Ethical Review committee to be able to undertake the project. INDIAsize had Independent review committee which is constituted of medical and non-medical members, whose responsibility is to ensure the protection of the rights, safety and well-being of human subjects involved in research study. This committee actively reviewed and monitored the project at every stage.

Fig 4- Scanning attire for upper garment Women

Fig 5- - Scanning attire for head

Fig 6- Scanning attire for lower garment

Fig 7- Scanning attire for INDIAsize

3.1.8. Consent forms

Each subject involved in human study has to essentially provide a written consent to certify voluntary participation. In INDIAsize consent of each and every participant of was recorded. A form informing them about the need of the study, expectations from them, time demand, safety protocols, data confidentiality, gratuity, information of responsible officers etc. was provided to them in the form. To safeguard the vulnerable population like minors, students & employees of NIFT, Illiterate and unemployed population provision of recording witness of subject's legally acceptable representative (LAR) or impartial witness to monitor the consent process was built into the consent form. The form was translated in 15 local languages for easy understating of all the participants .

3.1.9. Determination of Sample size and make

Sample size for INDIAsize was calculated as per stratified sampling process applied on Census data of 2011 following Cochran's formula [28] . Total sample size for the study was calculated to be 25577 which was further distributed on demographics of region, age, sex, income and community i.e. rural /urban.

- **Sex-** For INDIAsize both men and women were considered to be part of the study.
- **Age group** –as per National Youth Policy, 2014[29,] of India a person is defined as youth who belongs to the age group of 15 - 29 years while   National Council for older people 2014 (NPOP) [30] recognizes a person above 60 years of age, as senior citizen. Keeping these definitions in mind target population of INDIAsize was in the age group of 15 and above. ISO 15535:2012(E) suggests to break the group in 5 years multiples Hence Target age group is 15 - 65 above and Grouping of age followed in INDIAsize is as follows- $15 \le 20$; $> 20 \le 25$; $> 25 \le 30$; $> 30 \le 35$; $>35 \le 40$; $> 40 \le 45$; $> 45 \le 50$; $> 50 \le 55$; $55 \le 60$; $> 60 \le 65$ and above
- **Region -** The geographical location of the survey enables true representation of all the population of the country. The locations selected were such that all the target sample frameworks get addressed to justify the study as true representative of native population to capture maximum diversity within a region. For INDIAsize India was divided on 6 geographical regions and main cities from each region having maximum diversity and representation from all the cities within the region was selected for data collection. Data collection was undertaken from following regions (cities) for the study - North India(Delhi), South India (Chennai), East India (Kolkata) , West India (Mumbai), Central India (Hyderabad)and North East India (Shillong) .
- **Income –** As per New income categories released in 2017 in BCG report Indian consumers were categorised as Elite -Above 20lacs; Affluent -10.0 to 20.0 lacs; Aspirers- 5.0 to 10lacs; Next Billion -1.5 to 5.0 lacs; Strugglers- Below 1.5 lacs which was used as categories for data collection.
- **Community –** The Indian population was divided as rural and urban population and data collection was undertaken accordingly

3.1.10. Training of manpower

Once the method of scanning is established and all selections of sampling framework, posture, anthropometric measurement points, scanning attire, ethical clearances are completed the sizing survey is ready to be undertaken. The challenges thereafter are on the field.

At site of scanning there is requirement of a team of trained people to undertake the scanning and allied processes. Keeping in mind the uniqueness of the task the manpower of INDIAsize was trained initially and periodically through-out the period when survey is undertaken.

In INDIAsize following people were recruited and trained to undertake specific operations in each INDIAsize booth

FRONT OFFICE

- Receptionist-   were trained to inform about the scanning process, issuing unique bar code number, recording consent and answer queries thereof. They were fluent in local language to make local people understand the information accurately.
- Regional Investigator – were trained in proper recording of the socio-demographic data and interpretation of the responses of the participants. They were fluent in local language to avoid information loss in translation.
- Supervisor – were trained to issue gratuity, certificate of participation and were responsible for overall smooth functioning of the booth.

SCANNING AREA

- Anthropologist – were trained in guiding participants for taking correct posture. They were required to periodically take few specified girth and height measurements manually for in- process validation of the scanner measurements. They also ascertain the size of the participant and issue appropriate scan suit before scanning. They were required to have understanding of human anatomy and were trained in using manual anthropometric tools for data collection.
- Scanner Operations Executive –were trained in operating scanner and nuances for effective data collection, storing, uploading, cataloguing and security. They were trained to check the scan for appropriateness. In INDIAsize there was one male and one female scanner operator with each scanner to scan the Male and Female participants respectively keeping in mind the cultural constrains.

CONTROL UNIT

- Research assistant –was recruited and trained to be working in control unit supervising the requirements of the scanning sites, for checking the quality of scans remotely, to integrate the sociodemographic data with anthropometric data and to upload, categorise and store the data safely.

Correct selection and training of people on site is central for successful anthropometric data collection

3.1.11. Process of data collection in INDIAsize booth

The activity started with participant being tested for temperature by thermal scanners if found fit he/she is allowed in the front office area of the booth which is typically open from all sides.

Following process is followed in INDIAsize booth for data collection

STEP 1 – CONSENT FORM FILLING AT RECEPTION ON ARRIVAL -participant is welcomed and briefed about the project and process of scanning by the receptionist in English or local language. Receptionist checks and record the identity proof for verifying the age and citizenship of the participant. Biometric recording i.e. facial scanner is undertaken to avoid data duplication of participant. Unique barcode/ scan ID is assigned and pasted on the consent form. Participant fills the consent form and provide personal identification information like phone number address email id etc. Only after the consent form is filled and signed the participant is allowed to undertake the remaining process

STEP 2 – SOCIODEMOGRAPHIC QUESTIONNAIRE FILLING Regional Investigator fills the online Socio-demographic questionnaire by interacting with the participant in English or local language. All the responses are store against the issued barcode to maintain the privacy of the participant No personal identification information is in the form. The questionnaire captures the main socio economic demographics of the study i.e. sex, age, region, income and community. Apart from that there are other questions like life style, clothing preference, employment categories and job roles etc.

STEP 3 – SCAN SUIT ESTIMATION Supervisor /Anthropologist ascertains the participants size by taking few measurements by tape measure and identify the size of the participant for the scan suit and hand over the scan suit to subject. There are 8 sizes from XXS to XXXL available to be chosen from.

STEP 4 – DONNING SCAN SUIT IN CHANGE ROOM Participant after getting the scan suit enters a scanning area which is covered from all side to maintain the privacy of the participant. Participants changes into scanning suit and go to the scanning chamber through a curtained passage

STEP 5 – ACTUAL SCANNING IN SCANNING CHAMBER Scanner Operations Executive (1 male and 1 female) will scan participants in two identified poses and will check the scan for accuracy. Male participant will be scanned by male operator and vice versa to safeguard the privacy of the participant

STEP 6 – THANK YOU / SUPERVISOR'S DESK After the scanning process is complete, the participant will change back into their own clothes and step into the front office. They will be given a copy of the consent form for record. They will be handed over, by the supervisor, the gratuity which is a gift coupon and a certificate of participation signed by senior office in Government of India. Scan suit is also a give-away as thank you gesture for participation.

3.1.12. Pilot run

The scanner technology post selection and before undertaking a full-fledged survey needs to be to be tested under field conditions for performance and accuracy. A preliminary study i.e. pilot run may be undertaken on the small sample size with purpose of testing the whole process of measuring, to understand nature of survey and potential problem before undertaking the full survey. The objective of polit run is to standardize and stabilize the process of scanning, measuring, achieving accuracy, selecting landmarks and to solve any foreseeable challenges.

For INDIAsize three pilot runs were undertaken

- PILOT RUN FOR SCANNER PERFORMANCE- this was undertaken to validate scanner consistency, reliability and accuracy. The process involved using three trained anthropologist/measurers to manually measure some selected set of anthropometric measurements taken from randomly selected subjects. There were also scanned in multiple scanners multiple times. This anthropometric data from same scanner, from different scanners and the one which was manually collected were then compared to establish scanners consistency, reliability and accuracy.
- PILOT RUN FOR SELECTION OF ANTHROPOMETRIC DATA - The sample size of 379 people were selected which were in same proportion of stratified sampling frame work of the study. 133 people amongst were measured manually for all anthropometric measurements by two trained measurers and all 379 were scanned in two postures in the scanners (Ref fig 3) The main objective was to collect sufficient body measurements to make the selection of the measurements which were identified correctly and accurately by scanner with the specially designed of scan suits for the purpose and eliminate the ones which were not relevant or not identified properly. Also, the data was again used for establishing scanner's reliability and accuracy by comparing the manual measurement with scanning data.
- PILOT RUN FOR SYSTEM STABILIZING- This was undertaken with sample of 270 people randomly selected wherein full process of scanning, as would be undertaken in the field, was conducted in lab conditions to check for the potential problems and challenges likely to be faced on every step of data collection i.e. briefing and consent recording at reception, questionnaire filling at socio demographic data collection desk, scan suit issuance and posture making with anthropologist,

actual scanning with scanning operator and gratuity collection with supervisor. The experience of the participants and the data collection team was reviewed and analysed to make the process more robust.

3.2. Step 2 -Anthropometric survey

This is the process of actual data collection from the representative population and involves

3.2.1. Promotional activities and crowd incentivization to mobilize participation

The biggest challenge for any national sizing project is the crowd participation and meeting of the proposed sampling framework. Few of the typical recruitment process which have been undertaken are as follows
- Large scale propaganda, seminars, conference, talk shows, advertisements, banner, hoardings and news items in the region where survey is to undertaken.
- Issuing appointments on website of the project and giving first preference to people coming through appointments to save time of the participant
- Location of scanner in retail hub/ mall and inviting walk-ins
- Recruitment of agency to attract crowd
- Gift coupons to motivate crowd for participation

All the above have been used in the INDIAsize for meeting of the proposed sampling framework.

3.2.2. COVID related protocols

INDIAsize had a unique challenge of pandemic during the time the data collection was being undertaken. Both the data collection team and the participants had to be safe guarded against COVID. The mask, social distancing, sanitization protocols were made and implemented. All the data collection team were issued PPE with mask / face shields and gloves for there protection. Each participant was given individual pend for filling consent form and masks for protection. Scanning and scanning rooms were sanitized after each use. The roaster for the same was created for information of the participants and the data collection team. The sanitizer bottles were kept on each station of the booth and social distancing was maintained throughout the process with no crowding in waiting or scanning area. The pen used for filling of consent forms were given away to the participants and not reused.

3.2.3. Data quality assurance measures

Systems were put in place to track the data coverage and achieve data integrity.
SAMPLING FRAME WORK COVERAGE- Software was developed for constant live tracking of data coverage so that excess, shortage in sampling categories could be avoided and he desired sampling framework could be achieved. Targets were issued weekly to the data collection team which were closely monitored and new targets adjusted as per the coverage.
SCAN QUALITY- systems were put in place to check the quality of scans so that the poor scans were rejected on the spot and were not made part of the collected data to maintain purity of the data
- ON SITE- Scanner operators were trained and had checklist to evaluate the data quality. The participants were rescanned if scan quality was not acceptable
- IN CONTROL UNIT - Monitoring team in the control unit checked all the scans and reject the ones with defects which slipped onsite scrutiny so that collected data is of good quality

SAFETY MEASURES OF DATA DUPLICATION- Since the participants received a small sum as gratuity and scan suits as give aways there were chances of participants rescanning themselves. To avoid this situation and duplication of data two security measures was taken
- Facial scanners- Each scanning booth was equipped with facial scanners where the live data was collected and checked against the previously collected data to avoid duplication of data and maintain data purity
- Number of Aadhar Card issued by Government of India which is unique identity card was checked to avoid duplication of data

3.2.4. Data safety and protection

Data safety and protection protocols were developed and put in place for safety of participants and collected data
PARTICIPANTS- The personal identifying information of the participant is only recorded and stored in hard copy in the consent form. A Unique barcode id is issued to the participants which is pasted on the consent form.   All the responses of the participant to socio demographic questionnaire, body scan and avatar is store against this unique id in the government procured cloud service. No personal information

is stored in cloud to avoid any linking of body scan with participants personal information. No reference is made of the participants name or identification in any oral or written reports to maintain privacy.
COLLECTED DATA **–** The data collected is stored in Government procured cloud service having data protection and data retrieval systems to ensure data security

3.2.5. Data collection, sharing and integration

Protocols for data storing, uploading, sharing and integration were setup for streamlining the process. Software for collection of sociodemographic data was made inhouse to collect the data as desired. The protocol for data storing, uploading and sharing was created for collecting and recording data on site and sharing it with the control unit. Software for integration of socio demographic with anthropometric data was also developed inhouse so that the database can be created for making size charts that can be customized as per the requirement of the stakeholders.

3.3. Step 3- Anthropometric Data Analysis and Size system development

This stage is post data collection and involves statistical data analysis of the collected data to create body size chart which is representative of entire population Sizing systems have been developed and improved throughout the years using more and more sophisticated methods: simple mathematical techniques such as bivariate classification; statistical techniques like correlation coefficients; multivariate techniques, namely factor analysis using principal component analysis (PCA); programming techniques like linear programming (LP) and integer programming and non- linear optimization; data mining techniques such as cluster and decision tree analysis; and artificial intelligence techniques including genetic algorithms, neural networks, fuzzy logic and self- organization methods (SOM) are options available for analysis of the collected data . [32]
The process requires

- Identification of **Key/ Primary measurements –** which are essential to assign suitably- sized garments to the wearers
- **Range selection** for Key measurements- the extent of a size scale as defined by its extreme values (smallest and largest values)
- Selection of **size interval** which is incremental difference between adjacent components of a size scale and forming grading rule of all key and secondary measurements
- Categorization of **Body shape** & identification of **drop values**
- Identification of all **size rolls** i.e. Total number of sizes obtained from sizing system that cover the target population
- **Size system Validation** –Accommodation rate / Cover range (%) and Aggregated loss Goodness of fit
- Developing **Size designations/ Size label'** – i.e. how each size is identified on clothing or the tag. Numeric, alphabetic or graphic

3.4. Step 4- Garment size chart Development & Fit testing

This process involves conversion of body size chart to garment size chart which involves
- **Identification of garments**
- **Making of garment size charts for the identified garments by inclusion of allowances** for ease of wearing/movement, comfort and fashion styling, ease allowance to arrive at the required garment size chart.
- **Fit testing** This process involves testing 'Fit' of a garment developed form this size chart and evaluation of relationship between its dimensions and those of the human body through virtual and actual testing of garments

4. Participating demographics in INDIAsize

Data collection has been undertaken in all the regions and cities accept North east India which is currently being undertaken. The participation demographics as on end August 2022 is as follows

4.1. Region wise data coverage –

The target as envisaged is met 100% in North, West, Central and East India. 90% South India due to cultural constrain participation from women had been low and will be covered from other regions having south Indian population. Data collection is currently being undertaken in North-East region of India and likely to be completed by Mid-October 2022,

4.2. Sex-wise data coverage

As per census of India the male and female population distribution is 51% male and 49% female and data collection has been undertaken as per the same. 100% in North, West, Central and East India and 90% of South India target has been completed

4.3. Age-wise data coverage

Data coverage as per the age is also following the proposed frame work. Though there have been challenges in some age categories like 60 above. The participants of the age group were not able to hold the posture, they showed reluctance in changing clothes, the scans had to be retaken as they moved during scanning or they had natural sway in the body and were finding it hard to stand. Despite the challenges sampling framework has been met so far.

4.4. Income-wise data coverage

Data collection is following the income distribution as per the BCG report on India consumers income distribution basis which the stratified sampling was undertaken The challenge in collecting this data was that many participants were not willing to share their income and some were found to be understating it but still it is covered as proposed so far.

4.5. Community-wise data coverage

There has been low coverage of rural community as scanners are placed in retail and major cities so participants were from urban community more. Also there was reluctance in participants calling themselves from the rural sector and wanted to be associated with urban community.

4.6. Others

Participation from various sectors of employment, Category of employment and job roles is also mapped in the study to ensure participation from all sectors, profiles and levels so that study can be truly pan India with representation of entire population.

Sector of employment- representation of population has been from all the sectors of employment i.e. agriculture (people involved in agriculture, fishery, poultry etc.), business (people who are self-employed), private(people employed in private sector), public(people employed under state, central government or undertaking), retired, home makers, students.

Employment Category- INDIAsize has seen representation from all the employment sectors in India making study representative of Indian population. Employment categories represented in the data are from

- Agriculture, forestry and fishing
- Defence and Security   (Defence forces, Forest Police, Fire fighters, Paramilitary forces, Security Guards, Traffic Police etc.)
- Human/ Personal   services (Domestic helpers, Personal Appearance workers, Personal / Private services)
- Industrial, Manufacturing and Infrastructure (FMCG Jewellery Production Oil and Gas Power Infrastructure development & Real estate etc).
- Professional Services (architects, accountants, engineers, Journalist, Legal ,Science Technology Research & Engineering etc)
- Public Administration Utilities & Support
- Retail Trade and commerce- (organised and unorganised)
- Services- (Banking, Financial Services ,Community Service Education Health Care   Hotels Tourism, Telecommunication, IT services Media and Entertainment Transport etc)

Job roles

A **"job"** has been defined as a set of tasks and duties performed by one person. All the participants were mapped on job roles as per the guidelines of the National Classification of Occupations – 2015- as released by Ministry of labor & employment. Participation has been from all job roles i.e.

- Legislators, Senior Officials, and Managers
- Professionals
- Technicians & Associate Professionals
- Clerks & clerical support
- Service Workers and Shop & Market Sales Workers
- Skilled Agricultural and Fishery Workers
- Craft and Related Trades Workers
- Plant and Machine Operators and Assemblers
- Elementary Occupations

Education level

90% of the participating population was literate. While less than 10% were Illiterate; 25% had some form of formal school education; 40% had received high school to senior school education and 25% were college goers. Of all the participants 95% males and 85% females were literate.

The participation in the survey is as per the stratified sampling and all the strata of income categories, employment sectors, employment categories and job roles are represented which is testimony to pan India representation in the collected data.

5. Projected outcome

INDIAsize is one of the largest national sizing surveys being undertaken currently. The precise planning has led to immaculate execution despite the challenges of pandemic. There has been coverage of all sampling frame as planned so far. There has been participation from not only all the target demographics i.e., sex, age region, income and community but also all strata of society with representation from all employment area, employment sectors, job roles, educational backgrounds etc. The data collected is true representation of Indian Population. This will result in a creation of '*Size identification number*' for a customer through mapping, categorization and defining of their body size. This will help manufacturer to produce goods suited for the body size of the target consumer and help consumer to identify size which will be best suited for them resulting in a match and hence sales. The size charts thus created could also be customized for brands basis the demographics i.e., sex, age, region, occupation etc. of the target market. This customized sizing is a powerful and efficient business and marketing tool for manufacturers and retailers, which can help them to fine-tune their sales performance and reduce rejections by creating a balance between demand and supply of well-fitted clothes

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