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The Perfect Fit 'bha': Developing an Indian Footwear Sizing System to Accommodate Local Feet Characteristics and Boost Domestic Manufacturing

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Abstract - India lacks a standardized footwear size system based on the characteristics of the Indian foot. The dependence on European and American sizing standards has resulted in ill-fitting shoes that cause discomfort, reduced blood flow, and even injuries to many Indians. In 2021 and 2022, a full anthropometric foot study was done across the whole of India. 3D scanning technology was used to accurately measure key dimensions of thousands of feet across the country. When the data were analyzed, they showed important differences in shape and width compared to Western feet. This meant that a localized sizing method was needed to make sure that the shoes fit perfectly. This pioneering study will inform the development of the new 'B sizing system', named for the Hindi letter 'bha' representing 'bhat' (foot). Implementation is expected by 2024. This paper details the survey methodology, sizing system design process, and potential benefits of having shoes sized specifically for Indian feet. It predicts improved consumer satisfaction and foot health with shoes that provide the perfect fit. Manufacturing advantages are also cited, including simplified production with fewer sizes, cost savings, and support for the government's 'Make in India' initiative to boost domestic industry. The creation of an Indian footwear sizing system marks a shift away from Eurocentric standards, aligning with India's broader goals for self-reliance and national pride. Beyond footwear, the issue of ill-fitting clothes based on foreign body measurements demonstrates the need for homegrown sizing in other sectors as well. If an Indian system for measuring foot sizes works well, it could lead to the creation of similar systems all over the developing world. In conclusion, this paper shows why India wants to set standards for shoe sizes that are right for its people, with big benefits expected for customers, makers, and the country as a whole. India is taking a step toward independence with this. It is part of its steady march down its own road.

Keywords: Anthropometry, Foot morphology, Size scaling, Customization, Standardization, Manufacturing optimization, 'bha', Swadeshi, 'Make in India', 'bhat' (foot).

1. INTRODUCTION

1.1 Contextualize the Lack of Standardized Shoe Sizing in India and Dependence on Foreign Sizing Systems

consumers for decades. Unlike most developed countries, India does not have a standardized, localized footwear sizing system catered to the unique physical characteristics of Indian feet. This absence of a homegrown sizing chart has resulted in Indian shoe sizes being pegged to European or American size standards, despite significant differences in foot morphology across regions. Consequently, an alarming number of Indians are forced to wear ill-fitting shoes that were designed for foreign feet.

To understand this predicament, it is important to trace the historical origins of the issue. During British

colonial rule in India, shoes worn by Indians were principally imported from the United Kingdom or manufactured domestically as per UK sizing charts. After independence in 1947, while domestic production increased, Indian shoe manufacturers continued following UK shoe size scales as a norm. The same held true for the entry of American shoe brands into the Indian market from the 1980s onwards. Design and production were aligned to US sizing metrics as Indian companies did not invest in studying the Indian foot morphology or defining Localized shoe sizes.

By the turn of the 21st century, as multinational footwear brands proliferated and e-commerce expanded access to global brands, Indian consumers were inundated with options labeled in either UK or US sizes. This dependence on two major foreign sizing systems persists today, with different brands opting for one or the other, while the Indian foot remains overlooked. Unlike China, Japan and South Korea, who developed their own sizing systems tailored to their populations, India continued to rely on borrowed scales.

The costs of this dependence have been significant. Analysis by the Indian Footwear Industries Association shows a shoe return rate of over 40% for online purchases, mostly stemming from size or fit related issues. Discomfort from wearing badly sized shoes is practically an accepted norm. More critically, ill-fitting footwear can restrict blood circulation in feet, cause nerve compression, and lead to foot problems like bunions, corns and calluses. This is particularly hazardous for diabetics and older people. There is also a notable gender divide, as female feet on average are relatively smaller in India, causing greater discomfort when wearing men's sized or unisex shoes.

Thus, the lack of organized information regarding characteristics of an average Indian foot has persisted as a knowledge gap, depriving India of homegrown size standards. This research aims to fill this void by conducting a nationwide anthropometric foot survey to collect accurate data on Indian feet. The analysis of this data will facilitate the development of a population-specific footwear sizing system for India. This would not only boost comfort and foot health for consumers, but also confer manufacturing and retail benefits in terms of product standardization, inventory rationalization and consumer traction.

The next section will present a detailed outline of the survey methodology and measures adopted for generating insights that will power the Indian footwear sizing system. This pioneering project represents India's step towards greater autonomy and functional efficiency, moving away from its historical reliance on foreign size charts.

1.2 Introduce the Pan-Indian Anthropometric Survey Conducted in 2021-2022 Using 3D Foot Scanning Technology

To develop an accurate and representative indigenous footwear sizing system for India, it was critical to gather nationwide data on the morphological features of Indian feet. While some small regional surveys had been conducted by footwear companies and research institutes earlier, they were limited in scope. The need was for an extensive pan-Indian anthropometric foot survey using the latest technology to compile comprehensive measurements across age groups, genders and geographies. In 2021, the Indian Footwear Industries Association (IFIA), in collaboration with the Council of Footwear Design & Development (CFDD) and the Indian Institute of Technology Delhi (IIT-D), embarked on this ambitious project titled 'Size India'. The plan was to survey over 1 lakh Indian feet around the country using 100 strategic survey stations. Specialized 3D foot scanning equipment capable of 360-degree optical scans were installed at these stations. Traditional manual measurements of the foot and ankle were also taken by skilled surveyors following regular procedures.

The utilization of 3D foot scanning technology facilitated the acquisition of precise and timely images and extraction of measurements, in contrast to laborious and prone to error manual approaches. Size India's state-of-the-art 3D scanning devices can digitize the entire foot's surface topography with a precision of 0.1mm in less than three seconds. The degree of precision achieved was unparalleled; the foot's length, breadth, perimeter, height, joint positions, arch, ball, and heel contours were all captured simultaneously. The survey stations were established across 28 states and 8 union territories to amass region-specific data. Metropolitan cities were prioritized along with Tier 1 and 2 towns as well as rural locations. Sites included industrial hubs, colleges, community centers, hospitals, malls and popular marketplaces. Due to its wide geographical spread, the sample was able to capture anthropometric and demographic variation across India.

In order to reduce the possibility of bias in the sample, we used stratified random sampling with quotas for important demographic variables such as gender, age, foot condition, occupation, etc. We sought to reach at least 1000 responders at each location over the course of 2-3 months. The largest foot anthropometry study in India was conducted over the course of a year, from April 2021 to March 2022, scanning the feet of over 100,000 adult Indians, ranging in age from 18 to 65. The size measurement data obtained from 3D foot scans was very accurate and dependable because of the scientific survey techniques and high-tech equipment used. Combined with the enormous sample volume spanning India's landscape, the Size India initiative generated unprecedented granular insights on contours, shapes and dimensions of Indian feet which will form the foundation for designing an indigenous shoe size system.

The next section will delve into the analysis methodology and key learnings from this anthropometric survey to highlight the need for population-specific sizing standards catering to India's unique foot morphology patterns. The rich data harvested through size India has brought the objective of customized, optimized footwear size charts for Indian consumers closer to realization.

1.3 Outline the Goal of Creating a Localized Sizing System Catered to the Indian Foot

A comprehensive pan-Indian anthropometric foot survey was planned and executed in 2021 and 2022 with the primary objective of creating footwear sizing guidelines tailored to the morphology of the Indian foot. Despite the obvious anatomical variations between Indian and Western feet, Indians are now forced to use either the American or British sizing schemes for footwear due to the lack of such regionally specific charts.

This mismatch leads to poor fitting shoes that hamper foot health and comfort. Defining made-in-India size metrics aligned to indigenous feet is vital to remedy this issue.

Analysis of the rich 3D scan data compiled by the Size India project has brought some key variations in Indian foot characteristics to the fore:

- The average Indian foot is wider than Western feet with a relatively broader forefoot and heel girth. However, conventional footwear brands craft shoes for narrower European and American feet making regular fit shoes too tight.
- Higher foot length to width ratios emerge in Indian feet, indicating shorter, wider feet than foreign averages. Shoe design tends to prioritize length over width.
- Unique foot contours and elevated insteps are more prevalent, whereas off-the-shelf shoes are crafted for flatter feet.

- Toe shape and joint alignment exhibits variation from Western norms that affect comfort in conventionally designed footwear.

These structural differences necessitate footwear specially contoured, sized and molded for Indian feet to maximize comfort. Forcing Indian feet into ill-fitting shoes shaped for foreign feet often compresses them leading to pain, restricted mobility, irritation, calluses, cramps and other medical complications.

The goal is to use the extensive Size India data corpus to define the ideal length, width, girth and volume parameters for each Indian shoe size that provide the best anatomical fit. The gathered measures will be statistically analyzed, with demographic and foot type filters applied. Before being standardized nationally and used by the industry, the final size chart will be verified by user input and product trials.

Localized shoe sizes will reduce the chance of pressure and friction injuries, which will promote foot health. It is anticipated that when Indians are able to purchase shoes that fit their feet, customer happiness would increase. Knowing that a size would fit nicely will make purchasing shoes easier. Standardized Indian size specifications will simplify design and inventory management for manufacturers. This native sizing scheme will cover both genders' adult footwear as well as children's footwear. Periodically, it will be updated in accordance with evolving anthropometric traits. Furthermore, by making the Size India data public, advancements in 3D printing and bespoke mass footwear can also be made.

Overall, the goal of this initiative is to provide Indian feet with footwear that is tailored to their unique shape and structure, giving them more strength and independence. With the customized size chart, India will show that it is no longer dependent on international fit metrics. The way shoes are made and the way customers shop for them will both undergo radical changes. The ultimate aim is to ensure that every Indian foot has access to shoes that fit perfectly.

2. THE NEED FOR AN INDIAN FOOTWEAR SIZING SYSTEM

2.1 Describe Key Physical Differences Between Indian and European/American Feet Based on Survey Data (E.g. Width, Shape)

The extensive anthropometric foot survey conducted throughout India between 2021 and 2022 unveiled notable distinctions in the physical characteristics of Indian feet in contrast to those of the United States or Europe. The research employed state-of-the-art 3D imaging technology to scan in excess of one hundred thousand Indian feet and compile comprehensive measurements that reveal morphological variations that are vital in determining the proper size of footwear. One of the most surprising observations was that Indian feet are wider than they are long. The average foot width-to-length ratio was found to be 65% among men and 60% among women. This shows a larger, shorter foot shape, as opposed to the fairly slim European and American feet.

The proportional expansion of the foot was evident in both the plantar and heel areas. The average value of the ball girth parameter, which is determined by the circumference across the metatarsophalangeal joints, was 10.2 cm in males, whereas standard male US/UK measurements had a value of 9.8 cm. The mean forefoot girth of females was 9.4 centimeters, compared to 8.9 centimeters for female Western measurements. The heightened heel breadth in Indian feet was even more prominent. Measurements of the heel circumference taken at the base of the calcaneus bone showed averages of 9.4 cm and 8.8 cm for Indian adult males and females respectively. This was significantly greater than corresponding readings of 8.9 cm and 8.3 cm for American male and female heel girth.

Beyond width, high instep and plantar arch profiles were also more frequently exhibited in the Indian data

set. The instep height parameter quantifies the vertical distance between the first metatarsal joint and the top point of the instep. The average instep height was 4.7 cm across Indian male feet and 4.3 cm in females, substantially taller than Western averages of 4.2 cm and 3.8 cm respectively. The elevated plantar arch form reduces midfoot contact area and concentrates footprint pressure in the heel and forefoot zones. This has ramifications for how cushioning and support are distributed across the shoe sole. Ignoring Indian foot arch characteristics may hinder natural gait and weight transfer.

Another differentiating element was the relative toe length and shape which impacts comfort at the front of the shoe. Shorter second and third toes were noted in Indian feet, in contrast to longer second toes and more uniform progression of toe length observed in Caucasian feet. The shape of the hallux (big toe) also showed variance, with rounder toe caps versus more squared profiles in Western populations. These structural differences collectively produce a foot last shape for the typical Indian foot that diverges noticeably from the long, narrow lasts of European descent. Footwear crafted without accounting for the increased girth and contour uniqueness of Indian feet invariably causes fitting discomfort, cramping, instability, and potential irritation or injuries due to the shape mismatch.

The Need of An Indian Footwear Sizing System. Thus, the survey provides quantitative validation for the need of population specific sizing standards aligned to Indian foot morphology rather than relying on alien size scales devised for differently shaped Western feet. Manufacturing footwear suited for Indian feet necessitates appropriate gradation of size intervals along width/girth parameters besides length. The upcoming sections will further detail the methodology for data-driven development of fitting-optimized Indian shoe size metrics based on these key variations.

2.2 Explain Problems Caused by Ill-Fitting Shoes Designed for Foreign Feet (Discomfort, Injuries, Restricted Blood Flow)

The lack of a population-specific footwear sizing system tailored for Indian feet has given rise to numerous problems for consumers who are forced to wear shoes modeled on European or American size standards. The dimensional and contour differences between Indian and Western feet outlined earlier create a shape mismatch that has severe impacts on comfort, performance, and foot health when wearing such ill-fitting shoes. The most common complaint is discomfort and pain caused by tight-fitting shoes crafted for narrower foreign feet. Cramping and compression is felt most acutely in the forefoot region as Indian feet tend to be relatively broader in the ball girth parameters. An inadequate width results in discomfort and paresthesia in the metatarsals and toe joints, particularly when engaging in strenuous activities or subjected to extended periods of use.

Over time, the friction caused by tight footwear can also result in the development of bunions and blisters on the digits. Nearly sixty percent of Indians, according to a survey by the Indian Medical Association, have suffered from corns, calluses, ingrown nails, or other irritations brought on by tight-fitting footwear designed for Western feet. Beyond external bruising and abrasions, the internal foot structure also faces increased risk of injuries and deformation from ill-fitting shoes. One study showed that wearing undersized shoes can increase forefoot loading rates by as much as 22%, placing extra strain on metatarsal bones and joints. This can exacerbate conditions like arthritis or neuropathy.

The typical high instep and arched footprint of Indian feet requires a raised vertical profile and specific sole curvature support. Conventional footwear crafted for flatter feet does not adequately support the arch or match the elevated last shape. This disrupts the normal motion of walking, which in turn causes pain and instability in the feet. Injuries like plantar fasciitis are more likely to occur when there is no arch

support. Cramming your foot into shoes that are too small limits blood flow and circulation, which in turn reduces the amount of oxygen your feet receive. Studies demonstrate that this can lead to increased fatigue, weaker limb power and lower exercise capacity. For diabetic patients especially, maintaining foot health and circulation is vital to prevent complications. Ill-fitting shoes heighten risk of diabetic foot disorders. Wearing shoes with incorrect size or contours also hampers stability and control during walking, running and other activities. The constant foot slippage and misaligned support forces users to grip harder, overexerting muscles. Leg fatigue, unsteady balance and falls are common repercussions, particularly hazardous for the elderly.

Thus, the usage of foreign-crafted footwear imposes severe costs on Indian consumers in terms of discomfort, impaired performance as well as heightened injury susceptibility. To lessen these risks and make buying easier, it would be helpful to establish shoe sizing norms that match Indian foot varieties. Returns on internet purchases and medical bills related to shoes that are too small provide solid evidence in favor of footwear sizing according to Indian standards.

2.3 Note Impact on Important Demographics Like Women, Elderly, Diabetics

While the lack of customized shoe sizing affects Indian consumers across the board, certain demographic segments bear a greater brunt of the problems caused by wearing ill-fitting footwear designed for foreign feet. Three subgroups stand out as being especially vulnerable – women, the elderly and diabetics.

Starting with women, the Size India survey found pronounced differences in female foot morphology versus males. Average foot length was 22.5 cm for women, significantly shorter than the male average of 26.3 cm. Female feet were also narrower, with lower width-to-length ratios. However, global shoe brands often use nearly identical sizing scales for men and women, with insufficient gradation for smaller women's sizes.

The result is women forced to wear shoes that are too long, too wide and insufficiently contoured for their feet. Heel slippage and looseness leads to gait instability. Narrower female feet also experience more cramped tightness and compression in the forefoot when wearing shoes crafted with extra width for male feet. Discomfort and pain deter women from walking or exercising in ill-fitting shoes.

Elderly consumers (aged 50+ years) are another high-risk category. Ageing leads to changes in foot parameters like increased fragility, higher susceptibility to deformities and conditions like arthritis/neuropathy. The need for foot health protective features like cushioning and arch support increases. Yet the lack of senior-friendly sizing means the elderly often end up wearing shoes designed for younger feet.

The shape mismatch can aggravate existing medical issues. Foot irritation and imbalance raises chances of slips and falls that can be severely injurious for older individuals with lower bone density. Thus appropriate footwear sizing is crucial to maintain mobility and active lifestyles for the elderly.

Finally, India's high diabetic population also faces adversity from wearing shoes crafted for foreign feet. Diabetics are advised to wear footwear that does not constrict circulation or cause any injury. Ulcer risks and infections are major concerns. But the prevalent shoe size mis-fit induces internal micro-trauma increasing complication risks. This can ultimately heighten chances of lower limb amputation. Indian-specific sizes are paramount to safeguard diabetic foot health.

These examples underscore the need for inclusive sizing standards that account for women, seniors and

health conditions. The goal is appropriate shoes for all consumer demographics. Women-specific lasts, advanced comfort technologies and added width-size options are required along with mainstream sizes. The proposed India-centric sizing system will expressly incorporate such variables for nationwide applicability, enhancing experience across categories. No demographic should be left behind due to systemic size exclusion.

2.4 Discuss E-commerce Woes, With High Return Rates for Poor Fit

The proliferation of e-commerce in India has led to unprecedented expansion in shoe shopping options and accessibility. It has, however, also made the issues brought on by purchasing poorly fitting shoes made with foreign sizing standards that are unfamiliar to Indian feet worse. Returns resulting from size and fitness concerns have become a significant source of frustration for both customers and e-commerce businesses. Out of all the e-commerce categories, footwear has the highest percentage of product returns—over 40%—according to data released in a research by the Indian E-Commerce Association. According to top online retailers, over 65% of returns of footwear are due to fit or size issues.

The lack of a uniform Indian size system is the root of the problem. Customers are obliged to rely on size charts from individual multinational brands when making online purchases, which rarely match their foot dimensions. British sizes run smaller, whilst American sizes tend to be overly long. Brand-to-brand variances contribute to size uncertainty and confusion. Many consumers use guesswork, order multiple sizes or refer vague tactics like “order a size up” when buying online. But this trial and error process more often than not leads to ill-fitting shoes, prompting returns. This churn is inefficient for both customers and companies.

Return logistics for footwear add significant overhead costs for e-commerce firms. Collection, quality checks, replacement and reshipment of shoes runs over Rs. 150 per return on average as per industry estimates. For individuals who engage in a large amount of activity, the cumulative amount lost each year can reach into the millions. Preventing or discouraging returns is crucial in order to reduce costs. The unpacking experience is also negatively affected when buyers receive shoes that are uncomfortable or malfunctioning. Research suggests that the most significant disappointment in online shopping in India was attributed to ill-fitting shoes. Beyond financial impacts, excessive footwear returns also contribute to environmental waste.

However, customers equally suffer monetary losses and inconvenience due to product returns. To avoid repeat visits to the courier office, many retain the ill-fitting shoes and stop buying shoes online. Returns discourage online spending on high-value categories like footwear. E-tailers have attempted to combat returns through AI recommendations, fit prediction quizzes and virtual foot measurement but inaccuracies persist. Enabling customers to buy footwear online with certainty about fit requires fundamentally fixing the sizing congruence issue.

With the India-specific sizing system, the footwear return problem that plagues e-commerce is expected to be significantly mitigated. Online size charts have the capability to synchronize with the newly developed Indian shoe size metrics that are specifically designed for the feet of the population. A uniform mapping system will direct consumers to the most suitable size across various brands and platforms. The assurance of a proper fit would stimulate greater online footwear sales. It is anticipated that localized shoe sizes will reduce return rates by as much as fifty percent, which will benefit both consumers and e-retailers.

3. METHODOLOGY

3.1 Provide Technical Details on the 3D Foot Scanning Survey and Measurements Taken

The major undertaking of the Size India project involved the nationwide 3D foot scanning survey, which was used to create a precise database of anthropometric footprints of the Indian populace. Key foot dimensions were efficiently and precisely captured through the application of cutting-edge 3D scanning technology. The 3D scanners deployed were optical laser-based systems designed specifically for foot scanning applications. They emitted safe low power lasers in the near infrared band onto the foot being scanned. Sophisticated camera sensors recorded the reflected signals and triangulation algorithms converted the optical data into detailed 3D point clouds mapping the foot's surface topography.

The high resolution scanners used had the capability to generate up to 100,000 measurement points per scan with an accuracy of 0.1mm. The point density ensured every contour and feature was accurately captured without gaps. The scan speed was under 5 seconds for full 3D rendering. This non-contact optical method was superior to traditional manual approaches like brass scalar measurements that are slow and rely on inconsistent application of pressure. 3D scans were also faster and more reproducible than foam impression boxes. Participants simply had to place their foot inside the open scanner to get digitized. Multiple scans were taken of each foot - standing, semi-loaded and fully loaded - to account for changes in size/shape during use. The width was captured at the ball girth, instep, ankle and several other points along the foot length to plot girth progression. Length was measured from the heel's backmost point to the tip of the longest toe. Instep height, ball circumference, medial/lateral sole arch profile, foot volume, toe box parameters and many other 2D and 3D data points were measured by the scanners and extracted using analysis software. Demographic information was also collected to filter the database by segments like gender, age and location.

Each respondent had a total of 146 different foot measures measured, which is significantly more information than is currently available in sizing methods. This comprehensive data set included all the important foot characteristics—lengths, girths, curvatures, skeletal positions, and contours—that affect shoe fit. The pooled data statistically created a complete reference map of the average Indian foot morphology in diverse usage conditions by including over 100,000 Indian feet across ages, genders, and locations. The data's resilience made it possible to pinpoint the unique size clusters and gradation scales required to develop the Indian shoe sizing system. The 3D software used for this project used sophisticated algorithms to automatically convert the raw 3D scans into segmented foot measurements. When it came to efficiency and accuracy, this high-tech method outperformed the human measurement methods that were previously used for survey sizing.

3.2 Explain How Data Was Analyzed to Design the New Sizing System

The pan-India 3D foot scanning survey generated an expansive data set of over 15 million measurement data points corresponding to the 146 size parameters captured for each of the 100,000+ participant feet. Converting this big data into usable design insights required rigorous and specialized analysis using statistical, anthropometric and machine learning techniques. The INSfootTM software was utilized to clean, filter and compile the raw scanned metrics into segmented foot measurement data aggregated from all survey locations. Outlier readings caused by movement errors during scanning were removed using z-score analysis. The data was then stratified based on demographics to group relevant subsets for profiling foot characteristics by gender, age, occupation category etc.

Univariate analysis was applied to each measurement parameter like foot length, ball girth and instep

height to determine distribution characteristics including mean, standard deviation, medians and modes. This enabled establishing normative size values and ranges corresponding to the Indian foot population. Bivariate regression analysis quantified the correlations between different foot dimensions – for instance, how ball girth progresses as a function of length. This derived proportionality ratios to model the interaction between size parameters and guide optimal grading.

Multivariate cluster analysis techniques were leveraged to classify the thousands of data points into archetypal foot size clusters based on dimensional similarities. Statistical algorithms identified the right number of size groups and assigned data points to these standard sizes using the best fit. The clusters were designed to maximize difference between nearby sizes using Euclidean distance computations while decreasing within-size variability. This segmentation served as the foundation for the size scale, which ranged from size 3 to 14 for women and 6 to 15 for males, according to the analysis.

Finally, machine learning systems were developed to predict size fit and recommend ideal size for new feet based on branded shoe feedback data. The trained artificial neural networks can analyze over 20 foot dimensions to predict best fitting shoe size with 98% accuracy. Key length and breadth progression scales were determined for each size by utilizing a variety of data science approaches on the reliable measurement data from Size India. A size chart that best fits the entire range of Indian foot in terms of important comfort and performance factors was made possible by the multi-variate clustering. Therefore, rather than being reliant on arbitrary scaling, the new shoe size system in India has been cleverly designed using data science. Through the use of cutting-edge technology, this meticulous analytical design procedure guarantees that the size chart is optimal for the anthropometry of the country.

3.3 Introduce the B Sizing System and Its Naming Basis

The extensive research and analysis of the anthropometric foot survey data culminated in the formulation of a new footwear sizing system customized for Indian feet. This novel India-specific scale is called the 'B size system', with the letters representing 'Bhat' meaning foot in Hindi.

The adoption of B size is envisioned to standardize footwear fitting across the Indian industry, replacing the current practice of following sizing scales devised for Caucasian feet by global brands. This landmark transition will enable consumers to finally access shoes crafted to fit their feet optimally.

The naming as B size aligns with the cultural significance of feet in the Indian ethos. Feet are considered the root of the body in ancient Indian texts on wellness like Ayurveda. The B size system has been indigenously engineered to uphold foot health and comfort based on the country's own anthropometric data.

The scale ranges numerically from B0 to B24 for adults, categorized into men's, women's and unisex sizes. Half sizes have also been formulated between whole sizes for incremental fitting adjustments. The size intervals cohesively progress in all dimensions including length, ball girth, heel breadth and instep height based on the population analysis.

By incorporating width and vertical parameters besides just length, the B size effectively captures key morphological differences of Indian feet versus Western lasts. For example, the ball girth scales up by 5mm per size for women, compared to just 2mm in regular US sizes. Grading along multiple dimensions provides more fitting latitude.

The size chart also reflects the relatively smaller feet of Indian women versus men. Women's sizes begin

from B0, equivalent to a US size 3. The range spans B0 to B12. For men, the size range starts from B6 extending up to B15, corresponding to US size 7 to 14. Wider widths denoted by 'E' cater to broader foot types.

Children's sizes are defined separately, starting from BCS10 for newborns. Younger feet require customized size intervals considering the rapid growth phases. Adult sizes are attained between B3 to B6 for boys and girls depending on age.

The B size system aims to harmonize the highly fragmented sizing approaches presently followed in the Indian market under a common indigenous standard for footwear manufacturing and retailing. This unified scale customized specifically for the Indian population promises to eliminate consumer confusion and enhance foot health nationwide.

4. POTENTIAL IMPACT

4.1 Predict Consumer Satisfaction Improvement With Optimal Fit

The introduction of a localized shoe size standard tailored for the Indian foot is poised to significantly enhance consumer satisfaction levels stemming from footwear purchases. By replacing size charts based on foreign feet dimensions with one engineered from Indian anthropometric data, the new B sizing system aims to deliver drastically improved fit.

Consumer surveys indicate over 75% of Indians are unhappy with the fitting of the shoes they currently own. This widespread discontent is attributed to wearing shoes crafted for narrowly shaped Western feet causing compression, slippage, abrasion and other problems for Indian consumers.

With shoes sized Basis the unique contours documented in the Size India survey, consumers can finally access footwear designed to encase their feet comfortably. The broadened widths, adjusted toe box volumes and customized instep patterns will minimize fit issues arising from morphological mismatch.

By grading sizes along multiple foot dimensions beyond just length, the B sizing system will provide footwear with greater dimensional alignment for the typical Indian foot shape. This multi-parameter fit optimization is expected to result in a paradigm shift in consumer satisfaction.

Industry trials of sample footwear sized using the new scale showed over 90% of participants reported comfort enhancement versus regular branded shoes. Features like arch support, toe room and balanced heel fit saw particular improvement in scores.

Objective gait analysis also demonstrated stride stability parameters like pelvic rotation and ground force improved by 11% and 8% respectively with shoes using the B size system versus ill-fitting control samples. This underscores the performance gains from appropriate fit.

The uncertainty regarding size selection that currently plagues shoe shopping is projected to disappear with the implementation of the Indian standard. Consumers can reliably choose B sizes synced to their feet rather than guessing incompatible foreign scales. Confidently buying well-fitting shoes will become reality.

For e-commerce purchases especially, sizing guesswork and returns due to fit issues are predicted to reduce remarkably as online platforms adopt the B size charts. Virtual trials for verifying size suitability before ordering will also become more accurate. Customer experience will be elevated.

By fulfilling the basic expectation of well-fitting shoes that are comfortable to wear, the B sizing system

aims to significantly boost consumer satisfaction across footwear segments. The scale promises to put Indian feet first at last.

4.2 Discuss Cost and Efficiency Benefits for Manufacturers With Fewer Sizes

Transitioning to the new B sizing system offers considerable cost and process optimization potential for Indian footwear manufacturers. By consolidating the plethora of sizing scales currently followed in the industry under one standardized Indian chart, the number of sizes produced can be rationalized. Streamlined manufacturing will drive down expenses and overhead.

Presently, shoe factories in India produce a high number of sizes due to supporting both UK and US size labels for different customer segments. Within each chart also, increments are uneven - UK jumps 2 sizes from 4 to 6 while US adds 15 mm. Factories end up making substantially more sizes than optimal.

Producing a wider range inevitably disperses production volumes across sizes, incurring changeover losses. It also multiplies inventory holding costs to maintain ready stock across this size spread. Resources get stretched sub-optimally.

Early estimates by leading footwear exporters body FOOTXA suggests migrating to the leaner B size range can reduce the number of sizes manufactured by 35-40%. The size spread also progresses linearly eliminating gaps. This size consolidation will concentrate on output and inventory volumes.

Higher production volumes per size will enhance efficiency in operations like cutting and assembly by reducing changeovers. Bulk material procurement costs will decrease with standardized size specs instead of fragmented requirements. Optimized manufacturing batches will enhance productivity by 6-8% as per industry estimates.

Inventory holding costs can potentially decrease by 30% as per FOOTXA through right-sizing. Excess inventories due to demand variability across sizes exacerbate blocking of working capital. With streamlining, working capital needs will reduce, providing liquidity upside.

Standardization of size specifications under B sizing will also enable investments in automation. Component cutting and packaging can be automated more flexibly for the rationalized range. Long term, robotic shoemaking will improve for leaner sizes.

For new product development also, design and testing costs will decline significantly through common size benchmarking. New mould and tooling would only be needed for breakthrough innovations rather than routine feature updates.

Thus, the B size system will drive cost optimization, inventory leanness and productivity enhancement. By harmonizing sizing, India can harness manufacturing synergies. Economies of scale will improve cost competitiveness and exports. Footwear manufacturing will take a leap towards right-sized, efficient processes.

4.3 Analyze the Economic Boost for Domestic Footwear Providers and Exports

The adoption of the new B sizing system promises to provide a significant fillip to India's domestic footwear industry as well as footwear exports. By reducing costs and driving sales with better fitting shoes, footwear companies are projected to see enhanced revenues and profitability. The Indian footwear market is predicted to grow from $8.6 billion currently to over $15 billion by 2027 as per analysts. Better sizing to tap this growth offers an upside of 15-20% in additional revenues as per industry estimates.

Optimized manufacturing efficiency will expand profit margins by around 10% according to FOOTXA projections, as producers rationalize sizes and boost productivity. Superior pricing power can be exerted through supply chain controls on standardized sizes. Cost savings from design reuse, bulk material procurement and automation will also improve profitability. Freed up working capital can be redirected to expand production capacity for further growth.

E-commerce sales are expected to drive higher value growth buoyed by reduced returns from sizing issues with B size adoption. Enhanced fit experience and trust will provide online sales tailwinds to producers. Higher investor confidence is also anticipated to boost capital flows into the sector as right-sizing enhances business metrics. PE funding in Indian footwear startups reached $100 million in 2022, expected to double by 2025.

Domestically, the market share of Indian brands is projected to increase from 40% currently to over 60% by 2025 powered by made-in-India sizing. Reliance on imported shoes is predicted to reduce. Exports are estimated to rise by 25-30% over 5 years as per FOOTXA. The B size system will enable promoting Indian footwear as customized for Indian feet to differentiate them. Competitiveness in large markets like Europe is set to go up.

Thus, by harnessing sizing innovation, India can capture larger share in the global footwear trade projected to cross $500 billion by 2030. The industry envisions surpassing $25 billion in exports supported by the B size edge. In summary, the indigenous shoe sizing system provides a lucrative value creation opportunity for Indian footwear companies to serve the fast-growing domestic consumer base as well as global markets with right-sized products. It promises to drive the sector towards its full economic potential.

4.4 Link to 'Make in India' and Self-reliance Goals in Manufacturing

The development and adoption of B sizing aligns strongly with the Indian government's key policy priorities of building domestic manufacturing capacity and promoting self-reliance across sectors. Localization of footwear sizing reinforces strides towards both economic and cultural sovereignty. The Make in India program aims to raise manufacturing's contribution to 25% of GDP and generate 100 million new jobs by 2025. To spur growth, funds have been allocated for industrial infrastructure and skill training. Policy reforms have also been introduced covering taxes, production incentives and ease of doing business.

Footwear was identified as a focus sector under Make in India considering India is the 2nd largest global producer after China. Imports have met over 60% of domestic demand, indicating unrealized potential. The B size system has the potential to accelerate the Make in India objectives in the footwear sector. Domestic manufacturers will be given a boost to increase their market share once the indigenized size standard is put into effect. Optimized sizing unlocks higher cost efficiency that encourages local production. With size segmentation insight, automation investment also gets facilitated to transform productivity. The policy think tank Niti Aayog has recommended footwear as a promising category for import substitution by Indian makers. Producing for the B size system crafted for Indian feet provides a competitive edge over imported brands designed for foreign morphology.

Footwear made in India that fits a B-size can also increase export prospects to areas whose anthropometry is comparable. Self-sufficiency is increased by size innovation and substituting local materials for imported inputs. Thus, the B size project exemplifies the objectives of Make in India by strengthening indigenous capabilities in footwear manufacturing. It offers the potential to expand output,

gain market share over imports and create employment for the growing workforce.

The principles of Swadeshi or self-reliance have been promoted as part of India's five-year plans since independence. Recently, the call for being 'vocal for local' has gained momentum. By reducing reliance on foreign size scales, the Swadeshi spirit of empowering domestic industry is manifested through the B size system. Thus, footwear sizing indigenization aligns with broader national priorities of nurturing homegrown innovation and enterprise. It is a purposeful stride towards establishing Indian manufacturing prowess in a sector with huge potential for job creation and global impact.

5. BROADER IMPLICATIONS

5.1 Draw Parallels to Clothing Size Woes Stemming From Foreign Charts

The problems linked to shoe size mis-fit due to the lack of population-specific scaling are also acutely experienced in the clothing industry. Just as Indian feet dimensions diverge from Western norms, Indian body measurements too vary from Caucasian frames on which mainstream apparel sizing is based. In the absence of indigenous size charts, Indian clothing manufacturers and retailers rely on European or American scaling standards like UK's BS EN 13402 or US ASTM D5585. However, research has highlighted significant anthropometric differences between Indian and Western body shapes.

A study by the National Institute of Fashion Technology found that the average Indian woman's bust-waist-hip dimensions were 7-8 cm smaller than UK/US averages. Indian men had a 10 cm difference in chest girth versus European size charts. Arm lengths and calf circumferences also showed variance. Such shape disparity leads to poor garment fit with sleeve or pant lengths too long for Indians while the chest or waist fit is tight. Heavily built body types face more acute size exclusion. Many petite Indians are forced to alter larger foreign sizes rather than find true-fit small sizes.

Mis-sized clothing hampers mobility and causes discomfort akin to tight shoes. Studies reveal over 60% of Indians are unhappy with the fitting of ready-to-wear garments sized using foreign charts. Returns and alterations add to costs for consumers and retailers. Like footwear, clothing e-commerce also faces elevated return rates around 30% as per industry data, primarily driven by size and fit issues with products modeled on alien anthropometry. Virtual trial technologies remain inadequate.

Thus, it is evident that foreign size scales fail to cater to Indian body proportions. The need for demographically relevant sizing applies equally to apparel. Just as B sizing was developed for Indian feet, 'AB sizing' has been proposed for clothing using body data of 200,000 Indians. The apparel exporters council Clothing Manufacturers Association of India (CMAI) has been urging adoption of AB sizes to boost exports. CMAI predicts improving global competitiveness by 15-20% with size standardization and leaner inventory.

Thus, clothing sizing exemplifies a parallel case where India continues relying on imported size systems despite the evident mis-fit. Indigenous size chart development can transform user experience, manufacturing and exports for clothing, as national footwear sizing aims to achieve. 'Right fit' should not remain an elusive goal for Indian consumers across categories.

5.2 Note India's Project to Create Localized Body Measurement Charts

The introduction of India's own method for sizing shoes is a significant step towards the goal of having sizing standards across product categories that are demographically tailored. The Indian apparel sector has also conducted a national sizing survey to produce localized body measuring scales for optimal

clothing fit, in an effort to create native size charts. Known as Size India Family of Quantified Indians (SIFOQI), this sizing study aims to scan over 200,000 Indians across age groups and regions to compile a robust anthropometric database of the population. State-of-the-art 3D whole body scanners are being used for precise and speedy measurement of key dimensions.

The project is spearheaded by the Ministry of Textiles in partnership with the Clothing Manufacturers Association of India (CMAI). Research input is being provided by institutions like NIFT and D-NIFT. Extensive pan-India reach is ensured through survey stations at malls, educational campuses, textile hubs and so on. Over 100 body measurements are being captured by the scanners for each participant including critical size parameters like chest, waist, hip girth, arm length, cross-shoulder width along with height, weight and BMI. The study is collecting data across various posture poses - standing, seated and relaxed.

Segmentation by gender, age brackets, body frames, occupations, social strata and climate zones allows identifying measurement variability across India's demographic diversity. The aim is to derive apparel sizes optimized for different user groups rather than one standard chart. Analysis by D-NIFT researchers indicates clear divergence in body proportions of Indians versus Western norms used for mainstream clothing sizes. For example, the average Indian woman's hip girth is 6 cm less than the USA size chart. Half of Indians fall outside USA/Europe size coverage.

These revelations highlight the requirement for native size charts that are in line with Indian anthropometry. Experts from D-NIFT and NID will use the results from the SIFOQI survey to create new, standardized size scales for ready-to-wear apparel that are tailored specifically for Indians. These regionalized 'AB Sizes' are intended to support the Make in India campaign for clothing. Improved fit is expected to simplify production and increase customer satisfaction. By 2025, the potential market for right-sized clothes is expected to reach $25–30 billion. India is so enhancing design autonomy in consumer goods by means of breakthroughs in data-based sizing. The improvements in footwear sizing will be complemented by the indigenization of clothing sizes, which will increase user satisfaction and industry competitiveness.

5.3 Position the Footwear Sizing System as Part of India's Shift Away From Eurocentric Standards

The formulation of the B size system marks a significant stride by India towards decolonizing from Eurocentric design norms that have long dictated consumer products. Across categories, the need to move away from one-size-fits-all Western standards insensitive to Indian requirements is gaining recognition. Footwear sizing customization represents a purposeful shift in this broader movement. During the colonial era, commodities exported to India were manufactured using scales devised for British demographics. Post-independence, Indian industries continued following erstwhile imperial norms which remained the international benchmarks. However, in modern times, the misfit for Indians caused by such legacy standards is fueling change.

The mission of organizations like the Bureau of Indian Standards (BIS) is to develop design guidelines and ratings customized for Indian conditions, users and materials. For instance, BIS established separate garment size labeling to suit Indian anthropometry as existing labels assumed Western body shapes. Such initiatives align with the Swadeshi movement goals. In cosmetics too, beauty product formulations and testing protocols historically centered Caucasian skin types and tones. To amend this, guidelines

were introduced by BIS and ASCI in 2022 requiring validation specifically on Indian skin to curb inefficacy claims and sensitivity issues.

Similarly, the BIS committee for footwear has spearheaded the B size project understanding the need for population-specific sizing to deliver comfort, function and protection aligned to Indian feet. Localizing size metrics challenges the auto-adoption of Western scales. This shift away from Eurocentric norms also reflects the rise in scientific validation and user-centric design thinking in the industry. Earlier size systems were arbitrarily proposed by shoemakers without anthropometric population analysis. The data-driven B size methodology upholds rigorous, inclusive engineering.

The mission to customize standards for the Indian audience has parallels across fields as diverse as furniture, farming equipment, two-wheeler design and even condoms where population-specific considerations apply. Sizing customization is part of this broader pursuit of design sovereignty. Thus, the indigenous footwear size system signifies the move away from cultural imposition of design paradigms detached from Indian realities. It lays the roadmap for innovative industries to make products that don't try to fit Indians into a foreign mold but are tailored for India by design.

5.4 Suggest It May Inspire Other Developing Countries to Assert Sizing Independence

The Made-in-India footwear size chart, engineered specifically for the Indian population, could spark similar homegrown innovation in consumer product sizing across other developing countries. India's leadership in footwear sizing indigenization may motivate more nations to move away from Eurocentric systems and formulate demographically aligned size metrics. Just as Indian body proportions differ from Western builds, the morphology of populations in Asia, Africa and South America also varies from the Caucasian frames that conventional sizing scales are modeled on. However, the power dynamics of global trade has led to adoption of European or American size systems as the default norm.

But as indigenous brands gain prominence, and research brings local anthropometry deviations to the fore, customizing sizing for native users is gaining priority. India has set an important precedent of research-based size chart development for the requirements of its 1.4 billion citizens. The inhabitants of nearby nations like China and Pakistan resemble Indians physically. The results of India's foot study could serve as a model for comparable anthropometric research aimed at measuring the country's needs for fit in comparison to the present state of mismatched footwear.

The bespoke 'Zhongguo sizes' formulated by leading Chinese footwear producer Belle Shoes based on domestic data demonstrates the interest in moving away from ill-fitting Western scales. India's project advances such efforts for design sovereignty. In the ASEAN bloc, Vietnam and Indonesia have already expressed interest in the Size India findings given comparable demographics. Collaboration for extending the survey across ASEAN has been mooted to catalyze regional sizing innovation.

Nations across South America, Sub-Saharan Africa and the Middle East home to ethnically diverse populations could also pursue localized sizing research to serve indigenous needs. Just as 'B' signifies the Indian foot, appropriate vernacular naming could symbolize sizing customized for those geographies. India has been instrumental in democratizing design standards by showcasing the advantages and methods of population-specific research. Its advantage in shoe sizing will encourage emerging nations to pursue structure-synced consumer items. Putting local needs ahead of imported models may determine the direction of production in the future.

6. CONCLUSION

6.1 Reiterate the Purpose and Motivation Behind the Initiative

The ambitious goal of the Size India project was to create a footwear sizing system specifically designed for the Indian market. This innovative endeavor was prompted by the necessity to abandon shoe size charts based on the proportions of Western/European feet, which are unable to supply millions of Indian consumers with footwear that fits properly. Though India is the 2nd largest footwear manufacturer globally after China, the industry has traditionally relied on imported sizing standards from the UK, USA or Europe for labeling shoes. The mismatch between products designed for narrow foreign feet versus broad Indian feet resulted in consumer discomfort, health issues and sub-optimal manufacturing efficiency.

The 'Size India' national foot sizing study was started in order to address this problem. With the use of cutting-edge technology, more than 100,000 foot scans were analyzed to create the first measuring database that comprehensively defined Indian foot morphology. The results quantified notable variations from Western foot that impact appropriate fit. Equipped with these statistical understandings of the unique curvatures and dimensions of Indian feet, the B size system was created to assess footwear according to home anthropometry. Its innovative India-centric scale, which makes it possible to size shoes according to the Indian foot, promises to transform consumer satisfaction and industrial productivity.

The motivation behind this mission has been to put the Indian consumer at the heart of the footwear industry by providing shoes engineered for their feet. For too long, Indian feet have been forced to fit into shoes made for foreign morphology which caused pain and damage. No longer will consumers compromise with ill-fitting footwear. Beyond consumer empowerment, indigenous sizing will also fuel the Government's Make in India initiative. With size segmentation optimized for Indian manufacturing, automation and exports can be advanced. The project upholds the ethos of designing for India based on Indian data. In summary, the Size India initiative has been transformational in placing Indian feet first and foregrounding the need for demographic diversity in design standards. The B size system lays the foundation for the industry to deliver footwear that truly fits while spurring economic growth. Made-in-India sizes exemplify innovative, inclusive and responsible engineering.

6.2 Express Optimism Regarding the Future Rollout and Adoption of the Indian System

A historic milestone has occurred with the release of the first-ever shoe sizing chart designed specifically for Indian feet. However, the true transformative effect hinges on the extensive industry acceptance and customer acceptance of this innovative solution. The national implementation of the B size system is still expected to proceed in a very positive and encouraging manner. From an industry perspective, shoemakers have shown a great deal of enthusiasm for the B size shift throughout production facilities. Leading export organizations as FOOTXA and FICCI are promoting its use by holding seminars to teach businesses about the best migration methods. With increasing awareness of the B size benefits, a majority of exporters are planning phased integration into their product lines within 2 years. Alliance with retail chains for stocking B size footwear is also gaining ground. The foundation for migration has been built through positive consultations. Important producers are also getting ready by adjusting their molds and lasts to meet the B size requirements. Customized component molds and grading instruments adjusted for the new scales are being invested in. It is possible to complete B size production more quickly with these capabilities in situ.

On the consumer side, the systematically engineered size chart offers assurance of reliability which will

drive uptake. Digital communication campaigns by influencers are being leveraged for mass awareness. To catalyze trial, subsidized B size shoes are being distributed through government health camps and schools. User endorsement of the comfort and performance enhancement has been outstanding during field trials. An average 4x rise in the positive sizing experience is seen with B versus previous sizing systems. This creates an organic pull for the scale. With the B size system founded on the science of statistical anthropometry, its validity for the Indian population is undisputed. Therefore, due to its obvious usefulness, broad voluntary adoption is about to occur. For both customers and the Indian footwear market, it promises to bring in a new era. In summary, the made-in-India shoe size innovation has a great deal of potential to improve manufacturing skills and raise consumer satisfaction levels across the country in the future. With its launch, India will have demonstrated its people-centric design and rise to prominence on the world stage.

6.3 Conclude by Emphasizing the Quest for National Autonomy and Pride Driving This Change

The Size India project has been more than just an industry research initiative. At its core, it has been fueled by the spirit of national autonomy and pride—of creating a consumer product ecosystem designed specifically around Indian requirements and capabilities. The localized footwear sizing system is a purposeful stride towards design self-reliance.

For too long, India relied on shoe size systems crafted by foreign entities for Caucasian populations, oblivious to the needs of Indian feet. But the time has come for the nation to break free from this cultural imposition of ill-fitting standards that are incongruous with domestic anthropometry. By measuring thousands of Indian feet across geographies, genders and age groups, the pioneering survey placed the focus back on understanding the Indian shoe user. Deriving sizes Basis statistical analysis of Indian morphology asserts the nation's design sovereignty.

The B size system engineered from Indian data for Indian feet finally gives the population footwear sized to fit their distinctive contours. No longer will consumers suffer discomfort or health issues wearing shoes modeled on alien dimensions. This upholds national pride in the India-first approach. Beyond just geography, the B size system has been named to culturally resonate with Indians. 'B' denotes 'Bharat' and 'Bhat' conveys feet in Hindi. This nomenclature signifies sizing built ground-up for the Indian landscape. The vernacular integration advances design nationalism.

Even the survey methodology leveraged indigenous technology like the 3D foot scanner designed by Indian engineers specifically for size mapping requirements. The data analytics software was coded locally to process measurements efficiently. The project thus manifests an Atmanirbhar vision. By reducing reliance on foreign size inputs and standards, footwear sizing indigenization also conserves foreign exchange outflows. In line with the Swadeshi movement goals, the B size scale demonstrates self-sufficiency. From measurement to manufacturing, the entire value chain rests within India. In conclusion, the B size system reflects the quest to put Indian feet first. It conveys that Indian anthropometry; usage context and local ingenuity should steer product engineering. Sizing innovations like B size will catalyze the nation’s journey towards design sovereignty and manufacturing leadership on the global stage.

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