USER-CENTRIC DESIGN RESEARCH FOR TODDLERS' FOOTWEAR: CONCEPTUAL FRAMEWORK USING MULTIPLE RESEARCH APPROACH

Authors

Professor Shinju Mahajan, Ph.D., Department of Leather Design, National Institute of Fashion Technology, New Delhi, India

Professor Nilanjana Bairagi, Ph.D., Department of Textile Design, National Institute of Fashion Technology, Bengaluru, India

Corresponding Author: shinju.mahajan@nift.ac.in

Keywords

Toddler's Footwear, Footwear Problems, Footwear Material, Design Criteria, Interactive Designing

Abstract

Human centric design (HCD) is a popular tool for giving insight into the user preferences and as a means to create commercially viable products, and is increasingly becoming a standard for designing all utility based products. Incorporating HCD to understand the needs of the consumer and to conceptualize the designs for product development in synergy with the complex market dynamics is the key to a successful design that appeals to the masses as well as offering a design solution to the existing gap in the available product. In this paper, the researcher presents a unique conceptual framework for designing toddlers' footwear using a human centric design approach. The framework is based on the conviction that the extensive but selective methods of research can be applied to find preferences of toddlers in relation to their cognitive development and commercially available suitable materials for manufacturing toddlers' footwear. The framework introduces the concept, methods and model for the design process and product development. Fitting an infant's shoe is very challenging. An infant's foot is barely formed and just starting its physical development and hence, vulnerable to adapt to any fault in the shoe. The research addresses the needs of the 'consumer of today' which is more aware and needs individualistic, mass customized product that is focused on offering design solution to the gaps in the existing products. This scientifically designed footwear takes into consideration the foot anatomy of toddlers and the results have been verified by gait analysis of the users (toddlers); yet it keeps the complex market dynamics in consideration with respect to the consumer preferences viz a viz the aesthetics as well as the scalability of the product. An attempt has been made to show how multiple research methods and human centric approaches used in this research can incorporate a broad range of findings for understanding a toddler's preferences in relation to their cognitive development and their environment.

The framework also provides a premise for future researchers to adopt innovative research methods considering the limitations of the sample (toddlers) who can neither comprehend nor express their preferences like adults. In conclusion, based on the validations, this scientific design research has resulted in the development of framework that can be scaled up and adopted by future researchers for an area which still finds a lacunae for research and development owing to the small market size and limited span of usage of the product, that is, toddlers' footwear.

Introduction

Toddlers are beginning to adopt a mature and individualised gait pattern in their first three years of life, which are crucial years for the development of their feet and the health of their feet. Early on, the footwear impacts a person’s gait because sensitive, impressionable feet prefer to conform to the contour of the shoes. Therefore, it is crucial to pay close attention to footwear selection because fit and footwear are crucial for children's healthy foot development. Some researchers have researched the biomechanical impacts of shoes on children's gait patterns, on foot growth, on foot deformity, on corrective shoes, on foot anthropometry, and so on; nevertheless, there is insufficient literature on the design needs of toddlers’ shoes using a functional user oriented approach. Therefore, the research is aimed to develop a conceptual framework that would lead the researchers and trade practitioners to identify appropriate materials and suitable designs for toddlers' footwear using a user centric design research approach. This approach is characterised by:

1. problem analysis of user/ requirement thereby defining the ‘user requirements’;
2. transformation of these user requirements into measurable engineering requirements; and
3. an iterative design where prototypes are tested by users and modified by designers.

The study focuses on the Indian retail market for children's shoes. The market is poised for a significant retail expansion in this sector given the strengthening economy and rising disposable incomes. Due to a small market share, there are not many organised brands that serve this group of consumers.

Data from parents, toddler caregivers, footwear specialists, and orthopaedics were gathered during the pilot study to support the topic's applicability in the Indian environment. Though toddler footwear sales in India have significantly increased in recent years, it was discovered that little research has been done specifically on the newborn and toddler population in India with regard to footwear design and aesthetic preferences. When buying shoes for the toddlers, parents and caregivers expressed concerns about sizes, comfort, and design preferences.

Additionally, many Indian manufacturers did not follow the technical requirements since they were unaware of the significance of properly fitting shoes and the foot deformation they might cause (as stated by Indian footwear specialists) (Aiyar, 2014; Dutta, 2014).

In India, the performance attributes of shoes have not changed proportionately despite a rise in annual footwear sales. The lower end of the market is dominated by unorganised homegrown players, where research and development are lacking, while the higher end of the market is largely dominated by international brands (IBISWorld, 2010; Dutta, 2014). In addition, in-depth interviews with Indian footwear industry professionals found that, despite rising domestic demand for children's shoes, the Indian market is unable to satisfy the wants and demands of the target market. There is not any systematic research to define the materials for the uppers, linings, and soles of children's shoes (Aiyar, 2014). The lack of systematic design development process in the domestic market fails to address factors like the shape of the foot and the size variations seen in different parts of India and also the aesthetic preference of Indian toddlers' for design and colour (Dutta, 2014).

In the realm of toddler footwear, there has been little research on the design of footwear using a user-centric approach. In order to create a prototype that meets their demands, a user-centric design approach is used to constantly interact with users while observing and analysing users' behaviour while they are at work. The design of software interphase, product development, and so on, all make extensive use of this idea, which has established advantages over more conventional methods (Veryzer and Mozota, 2005). Thus, the research is important in providing a conceptual framework to guide researchers and industry professionals in identifying optimal materials and suitable designs for toddlers' footwear through the use of a user-centric design research technique. The goals include analysing toddlers' footwear-related issues, parents' issues with toddler footwear purchases, and the selection of appropriate materials and finishes for toddler footwear components based on factors like moisture absorption, breathability, flexibility, and tensile strength as well as the identification of toddler preferences for colours and patterns, which will ultimately result in the creation of a user-centered design. This involves a research of user preferences for colours and visual motifs through interactive workshops that were built with play in mind, where toddlers were shown graphic cards for colours and patterns and their preferences were recorded depending on their attention span. As a result, design concepts were further developed and tested for framing footwear designs depending on customer preferences (Mahajan, 2014).

Review and Theory

Early in childhood, shoes have a significant impact on how the foot develops. The foot is incredibly flexible and conforms to the shoe it is housed in, thus infants and toddlers who wear ill-fitting or inappropriate shoes risk developing physical deformities (Staheli, 1991). One of the main causes of foot problems is thought to be shoes. Infants and young children have distinct foot anatomy than adults. Under the foot, newborns have a layer of fat. This hides the foot arch, which forms between the ages of two and five years (Rossi, 1980).

According to studies, improper footwear choices made in early childhood are responsible for roughly 90 per cent of physically malformed feet in adults (Rossi, 2002). Shoes can cause corns on the foot and distort the toes. A compressive, rigid shoe may result in foot malformation. (Staheli, 1991).

There are no size guidelines for toddlers in the Indian footwear retail market, despite the existence of studies on the effects of footwear on the development of feet. For children's shoes that are more than 40 years old, the Bureau of Indian Standards (BIS) provides technical criteria, but there are none for toddler shoes (Parvatikar, 2014). It is interesting that there are no sizing guidelines for the local market. Local manufacturers only use one last width in the Indian retail sector, which is bad for the development of the foot (Manchanda, 2014). The footwear experts' knowledge indicates that the market lacks a national sizing system and is mostly dependent on United States, United Kingdom, and French sizes. The population of India is diverse and shifts from the north to the south or from the east to the west. In contrast to the inhabitants of the north and east, whose feet are often narrower and smaller in size, many people in India's north and south customarily wear no shoes and have wider feet. However, the footwear retail sector only uses one last size. As a result, many people are wearing uncomfortable shoes. Customers have few options for half sizes and widths on the market (Aiyer, 2014, Das, 2014).

Methodology

Hanington (2003) divided human-centered design research methods or user-centered design approaches into three categories: classic, applied, and innovative methods. These research methodologies were the foundation for this study. Market research, focus groups, surveys, and interviews are a few examples of conventional methodologies. These methods' data collection results in a strong overall picture of the design industry. Therefore, traditional methods have been used in preliminary research to determine user needs, identify gaps, and identify issues with footwear. However, as it falls short of meeting all of the requirements of the design process, the second way, the ‘Applied technique’, as indicated by Hanington (2003), which refers to employing research and development methodologies from design research, is applied. Qualitative ethnographic approaches like as observations, interviews, and interaction techniques are examples of applied methodologies. Furthermore, Onwuegbuzie et al. (2009) pointed out that ethnography offers qualitative methods for observing how design is implemented in practice and how social and contextual factors affect cognitive factors. This study on creating footwear for toddlers is based on qualitative design research techniques.

Hanington (2003) identified innovative methods as the final category of research methods. These methods include creative/participatory workshops, design workshops, card sorting, cognitive mapping, and so on. Some of these methods, which provide verbal and visual information, have been used to research Indian toddlers' aesthetic preferences for designing footwear uppers. The methodology adopted for this study is also based on Onwuegbuzie et al.'s (2009) guidelines for conducting design research, which include identifying the key design components, analysing the design in a variety of contexts, such as cognitive, educational, or classroom settings, and evaluating the design's material quality. The detailed research plan is visually demonstrated in Figure 1.

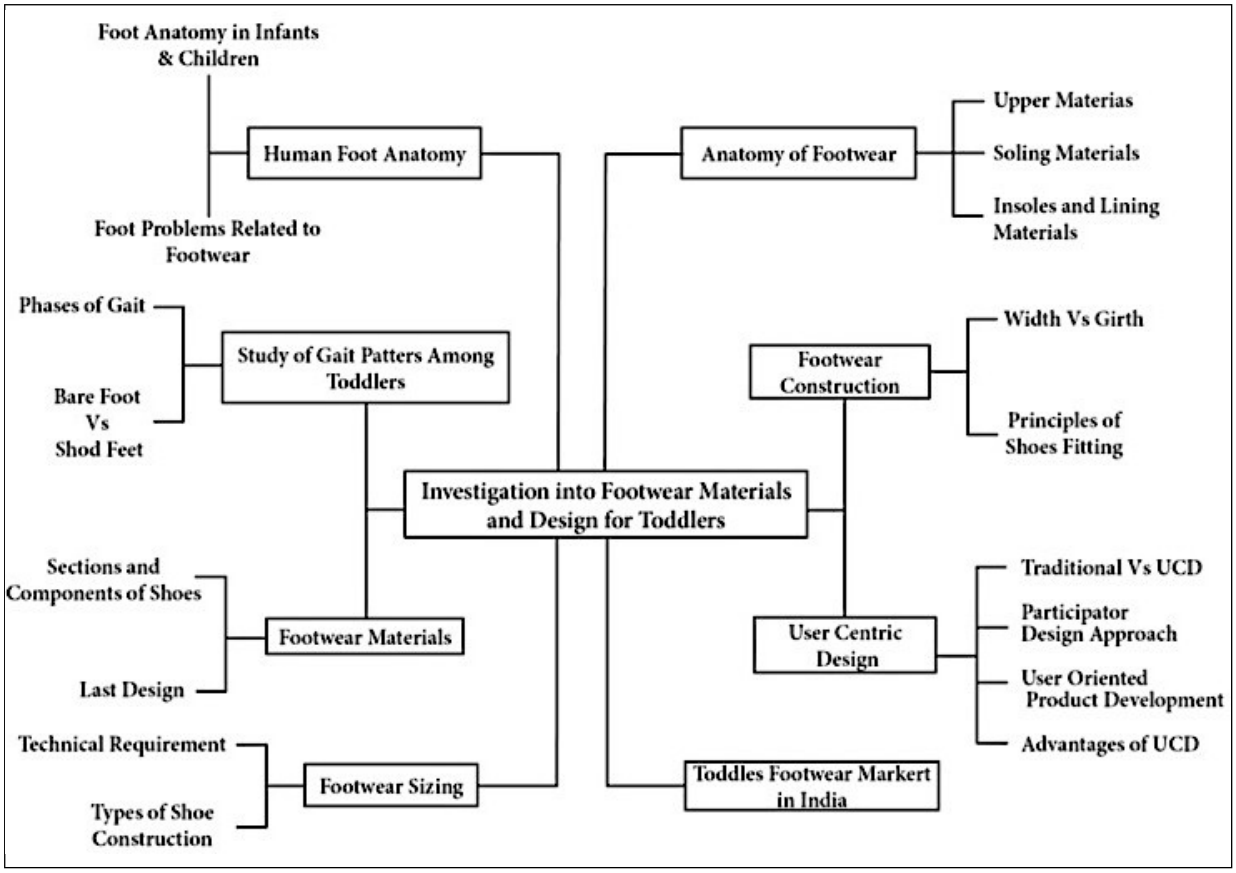

Figure 1. Research Plan

Identification of Users and Users' Needs

The study was carried out in India's National Capital Region (NCR) and urban neighbourhoods of Delhi. The statistical sample size was determined to be 500 toddlers using a 95% confidence level and a 4.5% confidence interval. All of the individuals selected for the study gave their consent. They were toddlers with normal gaits and foot development and no evidence of anomalies in the lower limbs. To be a part of the study, the toddler were required to fulfil the following criteria:

1. walk independently;
2. displayed normal growth and development as judged by the parents;
3. have no previous history of orthopaedic problem or treatment.

Parents of 200 toddlers who agreed to participate in the study were given questionnaires in order to better understand the needs of toddlers. These were either supplied to the parents through personal connections or were distributed to them by the play schools.

To further understand the issues with toddler shoe production in India, manufacturers of shoe lasts and footwear were questioned. Three orthopaedic specialists and surgeons were interviewed in order to comprehend how footwear affects gait in the early years.

Teachers who work in the play schools provided feedback on the impact of the type of footwear. It was critical to interview the shops who sell toddler footwear in order to better understand the styles of toddler footwear that are offered on the Indian market as well as consumer references in this sector. These interviews were done in both organised and disorganised settings, such as weekly markets and small local businesses.

Identification of Architectural Requirements for Toddlers' Footwear

It was vital to comprehend the sizing of Indian toddlers in order to comprehend the architectural requirements of toddler footwear. As a result, the feet measurements of 500 toddlers from the Delhi and NCR areas were taken. The toddlers' gait patterns were videotaped using the observation approach. Ten infants were video-graphed walking on a variety of surfaces, including grass, marble floors, tiled floors, and while running and ascending stairs. For the study, the toddlers had to wear shoes that were both closed and open in a similar design.

Six toddlers were used in pressure analysis experiments employing plate scanners to create scientific data for comparing an unshod individual's walk in a static position. The findings were utilised to create design guidelines for creating toddler footwear that is scientific (Figure 2).

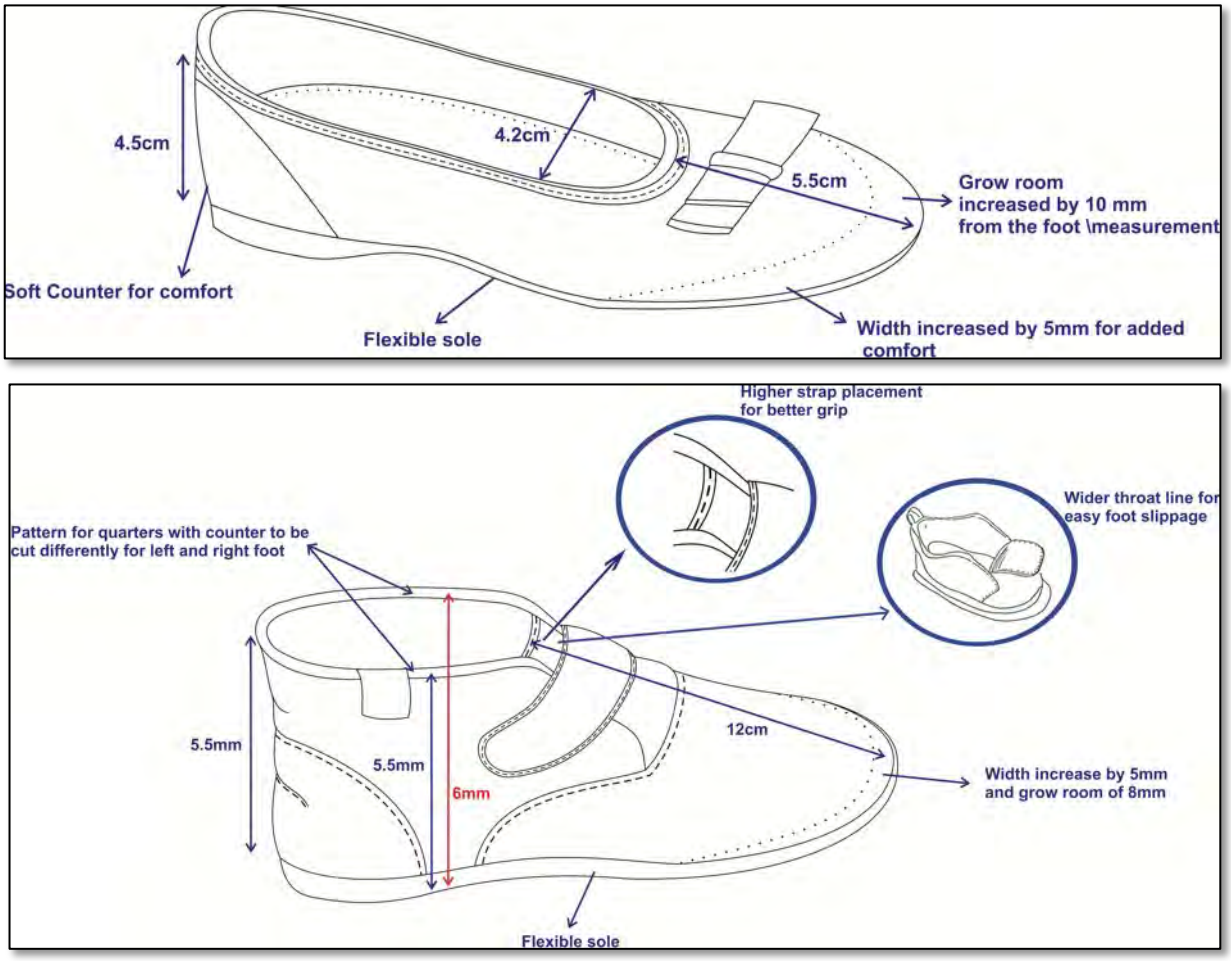

Figure 2. Architectural requirements finalized for development of toddlers’ footwear

Selection of Material for Development of Footwear

In order to produce footwear for toddlers, materials for the uppers, soles, interlinings, and trimmings were sourced and tested to determine which materials would work best given the user needs and constructional specifications. To choose the material for each component of a toddler's shoe that is high on comfort and fit relative to the commercial footwear being sold in the Indian market, a comparison of commercially utilised materials for various shoe components was done. Standard test procedures were used to further evaluate the chosen materials' appropriateness for shoe components in terms of their qualities. The materials' sturdiness, breathability, washability, air permeability, moisture transfer, moisture absorption, abrasion resistance, flexibility, colour fastness and other properties were evaluated. Pattern design parameters were also discussed with various pattern experts and manufacturers.

Accordingly, changes in the design of the patterns were made to make the fit better thereby increasing comfort. Prototype was developed using the selected materials. Figure 2 details the design parameters, selection of material for designing footwear for toddlers.

Aesthetic Design Development For Footwear

When users and other stakeholders are making purchasing decisions, visual design elements are quite important. Children as early as 4.5 months have shown the ability to distinguish between several items using information from an object's feature. Examining their attention span is a component of some of these exams. Based on the "visual preference approach" method developed by Fantz in 1961, interactive workshops were created. Due to the toddlers' lack of vocal expression, the feedback was collected via measuring their attention span. By displaying visual colour and graphic cards to toddlers over the course of numerous trials with set durations and tracking how much time they spent fixating on the cards overall, visual preferences in toddlers were assessed. This provided insightful data about toddlers' preferences related to colours and design details.

Prototype Development

The product analysis and selection of the solution was based on the evaluation of the prototype. The evaluation of design parameters was based on the design derivations from the research. Prototype was developed using the selected material and creating new patterns according to the architectural requirements researched upon. Physical testing and wear trials were done, to see the effect of the experimental prototype on gait of the toddlers as against their unshod condition. Final selection was based on the testing results of the material.

Prototypes were then developed and evaluated. Figure 3 shows the detailed methodology adopted for arriving at the final prototype.

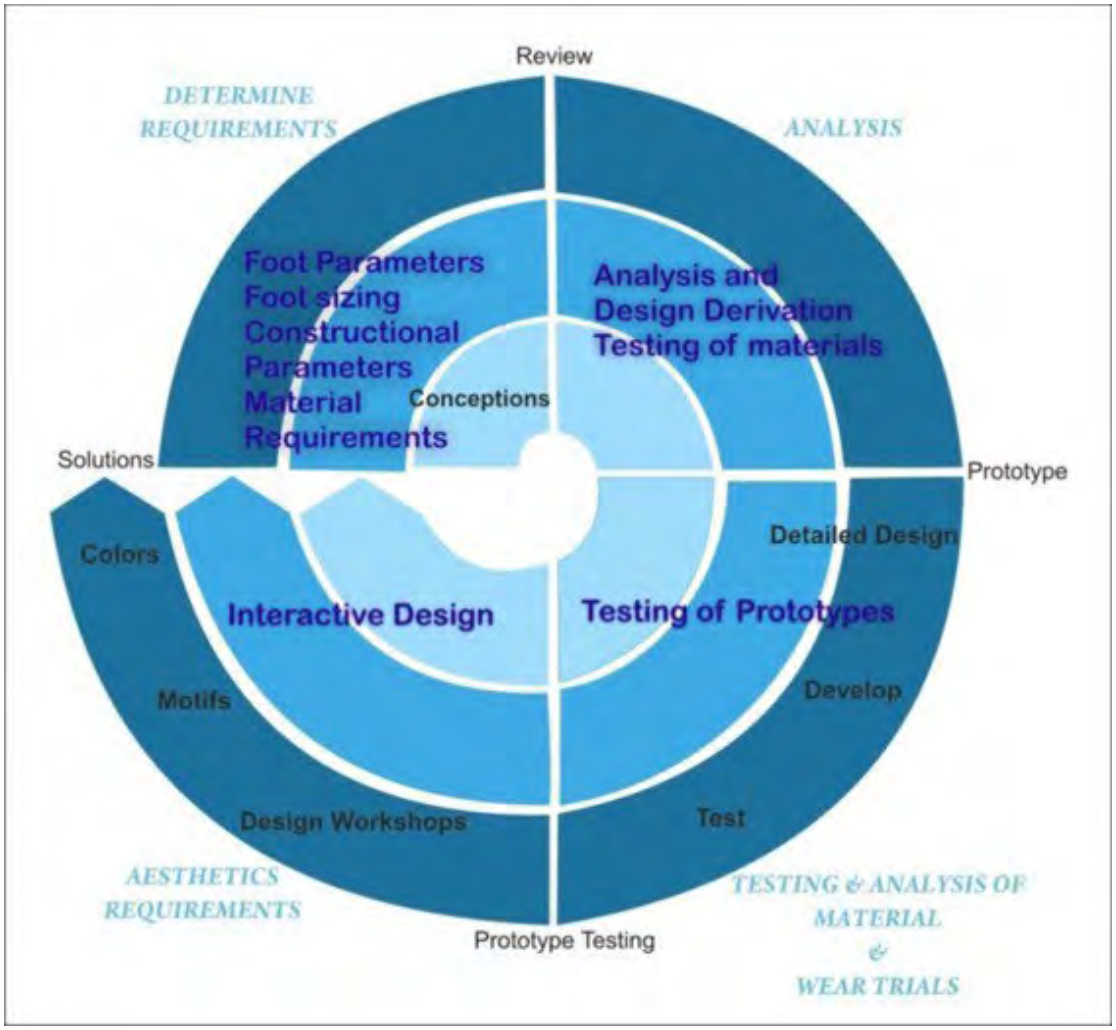

Figure 3. Methodology for designing of footwear for toddlers

Evaluation of Prototypes

Physical wear trials were performed on 25 toddlers with normal gaits wearing shoes in sizes 22 (for girls) and 24 (for boys) in February and March 2014 in New Delhi, India, where the temperature ranged from 25 to 27 degrees. The mothers of the toddlers received questionnaires.

Pressure plate scanners were used to measure the effect of the toddler's footwear on his or her stride. Readings were taken on toddlers who were wearing shoes and those who were not. The design choices for choosing the appropriate materials and pattern designs for a scientific toddler shoe were made based on the findings of these investigations as seen in Figures 4 and 5.

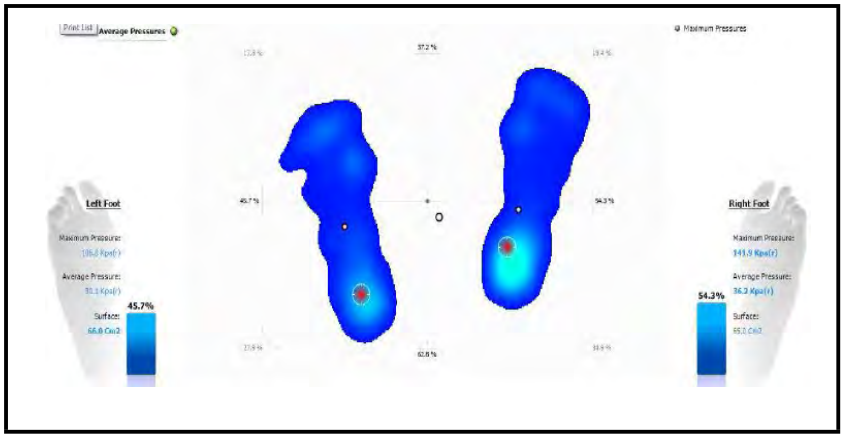

Figure 4. Dynamic gait analysis in unshod condition

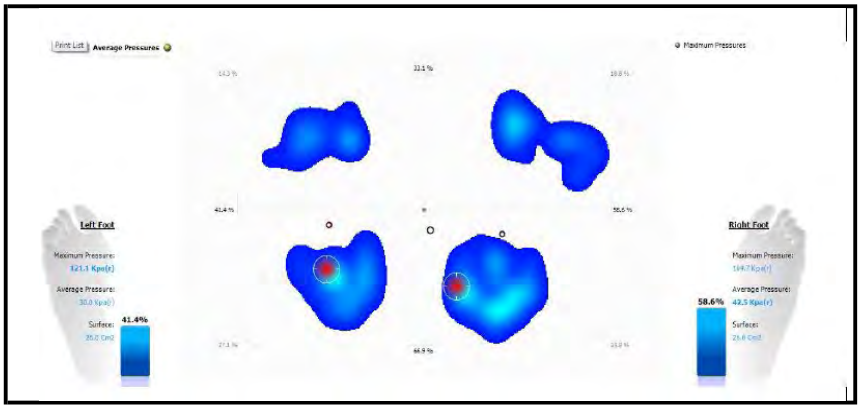

Figure 5. Dynamic gait analysis in shod condition

Results and Discussion

According to the study, due to lack of indigenous sizing, 28 per cent of children cannot obtain shoes in their size in the Indian market because commercial companies work with international sizing as vivid as US sizing, UK sizing, French sizing and Chinese sizing. Due to the short lifespan of shoes, this market sector is mostly price driven and 92 per cent of parents are unaware of the dangers of using the wrong/inappropriate materials for the footwear worn by their wards. The study also sought to determine Indian toddlers' aesthetic preferences for upper shoe design adopting a user-centric approach. Through participatory, sensitively developed workshops with the toddlers, the preferred colours and design elements of toddlers were investigated. This study revealed that children between the ages of 18 and 23 months had no clear colour preferences and preferred simple, rounded shapes. Gender labelling was evident in toddlers older than 24 months, which led to the observation of particular colour and graphic preferences. Pinks and pastels were chosen by girls while boys preferred blue and red. The most popular cartoons, vehicles, dolls, and other items served as inspiration for the graphics. Based on the design parameters selected, the materials selection and the aesthetic elements identified, a range of footwear were developed and tested.

Users deemed the prototypes created as a result of this research to be visually pleasing, and they were able to achieve a gait in shod state that was as near to the gait in unshod condition as possible. The framework for the generalised design solution of convincing design criteria for creating footwear for Indian toddlers is presented at the end of the study (Figure 6). Thus, it is demonstrated that a user-centric design research approach to footwear production can offer design guidelines for the creation of useful as well as visually pleasing footwear for toddlers.

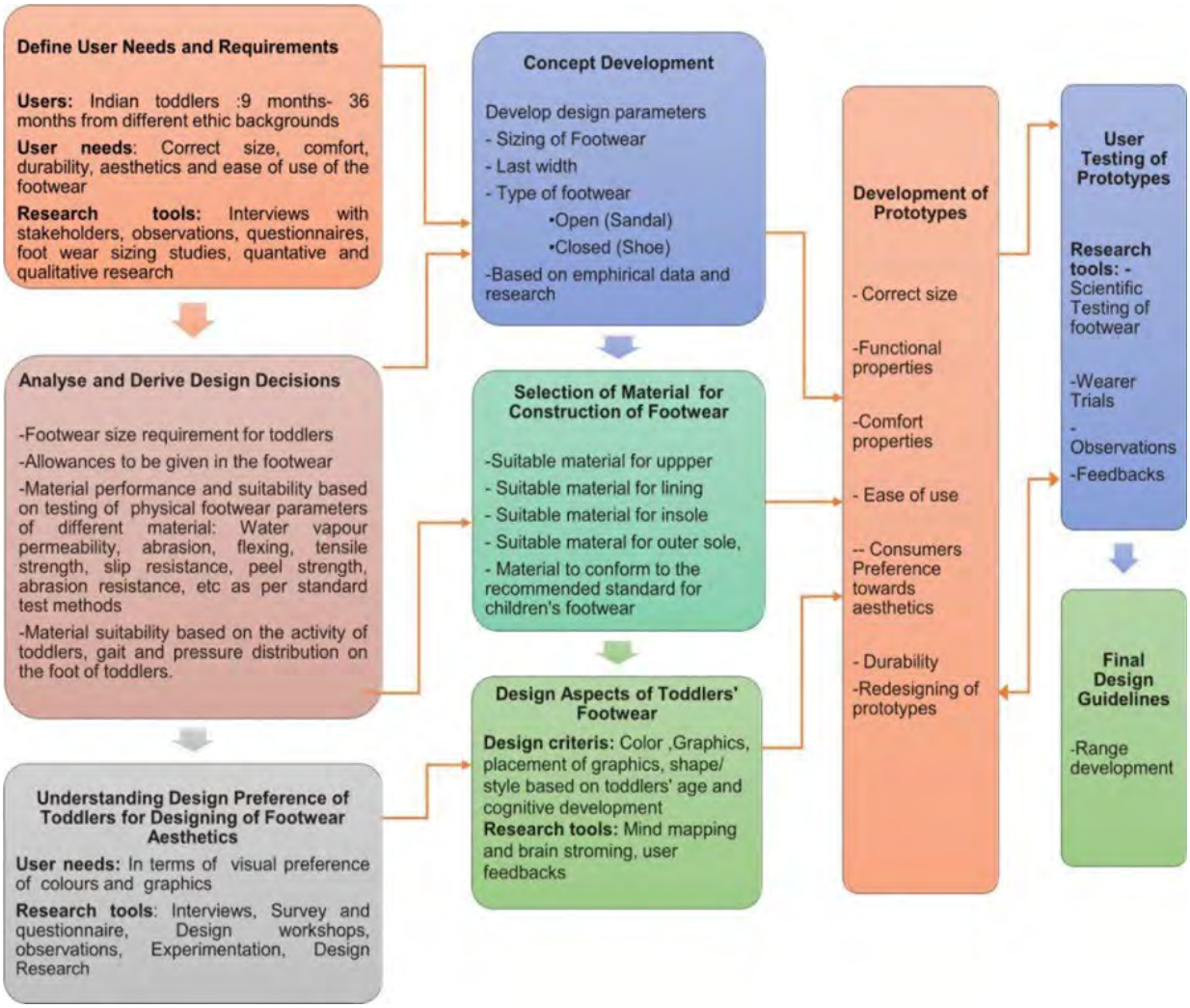

Figure 6. Conceptual framework of development of toddlers' footwear

The model has been successfully validated over a period of two years for different design projects with companies dealing with toddlers' footwear for the Indian market synergizing the technical and aesthetic requirements of the consumers.

References

Aiyar, G. K. (2014, 12 July) Interviewed by: Mahajan, S.

Bhaskar, S. (2010). India's footwear retail Entry: Opportunities, Issues and Challenge. India: *Browne & Mohan*.

D'AoÛt K., Pataky T. C., De Clercq, D., & Aerts P. (2009) 'The effects of habitual footwear use: foot shape and function in native barefoot walkers', *Footwear Science*, *1*(2), pp. 81–94. https://doi.org/10.1080/19424280903386411

Das, B. N. (2014, 14 October) Interviewed by: Mahajan, S.

Dutta, R. (2014, 18 July) Interviewed by: Mahajan, S.

Goonetelleke, R. S., Khalid, H. M., Lim, T. Y., & Lee, N. K. (2003) Designing footwear: back to basics in an effort to design for people. *Kuching, Proceedings of SEAMEC* 2003.

Hanington, B. (2003) 'Methods In The Making: A Perspective On The State Of Human Research In Design', *Design Issues*, *19*(4), pp. 9–18. https://doi.org/10.1162/074793603322545019

IBISWorld Industry Report (2010) Published by Global footwear manufacturing.

Luximon, A., & Goonetilleke, R S. (2003) Foot land marking for footwear customization, *Ergonomics*, *46*(4), pp. 364–383.

Manchanda, D. Interviewed by: Majahan, S. (23rd January 2014).

Ministry of Statistics and Programme Implementation (2012) Children in India, A Statistical Appraisal, report by Social Statistics Division, Central Statistics Office, Government of India.

Onwuegbuzie, A., Johnson, R., & Collins, K. M. T. (2009) 'Call for mixed analysis: A philosophical framework for combining qualitative and quantitative approaches', *International Journal of Multiple Research Approaches*, *3*(2), pp. 114–139.

Parvatikar. Interviewed by: Mahajan, S. (12th September 2014).

Rossi, W. A. (1983) 'The high incidence of mismated feet in the population', *PubMed Foot Ankle*, Volume 4(2), pp. 105-112

Rossi, W. (1999) 'Why shoes make "normal" gait impossible', *Podiatry Management*, pp. 50–61.

Rossi, W. A. (2001) 'Fashion and Foot Deformation', *Podiatry Management*, pp. 103–118.

Rossi, W. A. (2001) ‘Footwear: The Primary Cause of Foot Disorder’, *Podiatry Management*, pp. 129–138

Rossi, W. A. (2002) ‘Children’s Footwear: Launching site for adult foot ills’, *Podiatry Management,* pp. 83–100

Rossi W. A. & Tennant R. (1984, reprinted 1993) ‘ Professional shoe fitting’, *National Shoe Retailers Association,* New York.

Staheli, L. T. & Griffin, L. (1980) ‘Corrective shoes for children: A survey of current practice’, *Paediatrics*, 65, pp. 13-17.

Staheli, L. T. (1991) ‘Shoes for children: a review’, *Paediatrics*, 88, pp. 371–375.

Veryzer, R. W. & Borja de Mozota, B. (2005) ‘The Impact of User-Oriented Design on New Product Development: An Examination of Fundamental Relationships’, *Journal of Product Innovation Management,* 22, pp. 128–143.