Engineering Transformation in Sri Lankan Footwear Industry: Harnessing CAD/CAM for SME Evolution

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Abstract: Developmental strategies are crucial for the advancement of Sri Lanka's Small and Medium Scale Enterprise (SME) footwear industry, especially considering their current status and the global landscape of the footwear industry. This study examines the existing state of technology utilization in the SME footwear sector and proposes solutions for its technological development. To gauge the present scenario and understand industry needs, interviews were conducted with a sample of stakeholders from the footwear industry. The findings highlight the current status of Computer-Aided Design/Computer-Aided Manufacturing (CAD/CAM) applications and stakeholders' perspectives on a proposed "Common Resource Centre" (CRC) for the potential SME footwear industry. The research underscores the importance of integrating advanced technologies, such as CAD/CAM, into SME footwear businesses to enhance their competitiveness and sustainability in the global market. The proposed CRC could serve as a centralized hub for technology adoption, training, and resource sharing, fostering innovation and growth within the SME footwear sector. By addressing technological gaps and facilitating access to resources and expertise, these strategies aim to propel the Sri Lankan SME footwear industry towards greater efficiency, product quality, and market reach, ensuring its resilience and success in a dynamic global environment.

Keywords: Footwear industry, CAD/CAM, Developmental strategies, Small and Medium Scale Enterprise (SME), Common Resource Centre (CRC), Sustainability.

Introduction

CEB is the dominant power supplier to the national grid of Sri Lanka and controls all major functions of electricity generation, transmission and distribution in Sri Lanka.

Sri Lankan footwear industry approximately consists of 7 large scale (LE), 30 medium scale and 3,000 small-scale manufactures (Gunarathne, 2007). At present, the industry employs around 20,000 people (Gunarathne, 2007). Value addition in the footwear sector is between 40% and 50% (Perera, 2007). Exports of footwear during January to June 2007 were US$9 million, indicating a 42.74% growth compared to the corresponding period in 2006 and the major export markets for footwear was the United Kingdom (32%), Italy (25%), Spain (12%), the United States (7%) and Japan (6%) (Gunarathne, 2007). The SMEs in footwear industry in Sri Lanka has a long history extending centuries back, but the technology used in designing and manufacturing have hardly changed over the years (Fernando, Jayatilake, Mahindarathne, Kahangamage,

Mangala and Punchihewa, 2005a). However, technology is being developed and applied in footwear design and manufacturing around the world (Fernando et al., 2005a). In order for the SME sector to survive and thrive in this competitive market, advanced technology may be introduced among other incentives

Rationale behind the Research

Several common strategies for enhancing technological capabilities include modernizing outdated facilities, integrating factory automation with machine vision systems, and implementing CAD/CAM applications. However, the practicality of applying these solutions may be limited for small and SMEs due to economic constraints.

A study conducted in 2005 (Fernando et al., 2005a) identified several barriers hindering the progress of the footwear industry: lack of communication channels among manufacturing firms, insufficient planning, and inadequate utilization of engineering expertise. To address these challenges, the adoption of CAD/CAM technology through a shared resource center (CRC) for design and manufacturing activities is proposed as a viable solution. While not a novel concept, previous authors (Fernando et al., 2005a) have also advocated for the establishment of such centers, emphasizing their potential to benefit the entire footwear industry by reducing production costs for local manufacturers and enhancing competitiveness in the global market. Moreover, universities and technical institutions can play a crucial role in providing technical support to bridge the technology gap (Fernando et al., 2005a). Leveraging domestic expertise, the transfer of technology to the footwear industry can be facilitated (Fernando et al., 2005b). The present study aims to build upon the findings of Fernando et al.'s 2005a research by further exploring these themes.

Objectives

In this endeavour, the research study aimed to achieve the following objectives:

- Identify the stakeholders involved in the Sri Lankan footwear industry.
- Identify the CAD/CAM applications currently available within the footwear industry.
- Assess the current status of CAD/CAM applications in the Sri Lankan footwear industry.
- Develop a strategic plan to address the issues identified through the research.

Methodology

Fourteen semi-structured interviews and four unstructured interviews were conducted to collect data from the industry.

The stakeholder sample preparation

No clear statistics are available regarding the industry composition However, it was revealed that the composition is approximately about 7 LE, 30 medium scale and 3000 small-scale (cottage) enterprises in Sri Lanka (Footwear News, Nov-Feb 2007/2008e; Gunarathne, 2007; Perera, 2007). According to that, the total number of SMEs in the country is 3030. However, most of these 3000 cottage entrepreneurs are self-employed or sub-contractors as per the Industrial Development Board (IDB). Hence, CAD/CAM facilities provided by a CRC may be used only by

SMEs with a potential to absorb technology. Assuming that 80% of medium scale enterprises and 0.3% of small-scale enterprises have the potential to absorb technology, the potential SME population was calculated as follows. Potential SMEs $\xi_i = (30 \times 0.80) + (3000 \times 0.003)$ = 33..... (1)

Keeping the above figures in mind, data was collected from a sample of managers (n_x=14) from a randomly selected LE and SME organisations that involve in shoe and accessory manufacturing where 3 participants represented LEs and the rest were from SMEs.

The expert sample preparation

A panel of experts, consisting of four individuals, was carefully chosen to provide insights for the development strategy targeting small and SMEs within the footwear industry. The selection criteria prioritized expertise relevant to SMEs. Specifically:

- Two experts were drawn from the IDB, which is actively engaged in supporting SMEs in the footwear sector.
- One expert was selected from the SME Footwear Association, leveraging their direct involvement and understanding of SME dynamics within the industry.
- Another expert was chosen as a representative to the advisory committee of the Export Development Board (EDB), bringing valuable perspectives on export-oriented strategies and industry development.

Semi Structured Interviews

Data was collected from a sample ($n_x = 14$) drawn from the target population (ξ_i). The sample of organizations was selected based on the list of manufacturers available at the IDB of Sri Lanka. Participation in the study was voluntary, and informed consent was obtained from every participant. On average, each interview lasted for 30 minutes. While participants generally showed a positive attitude towards providing information, three declined to participate.

The interview guide included an introductory page providing a brief overview of the project. Interviews were conducted using this guide, with introductions to every question. The interviews consisted of a combination of open and closed-ended questions, with probing questions used throughout to gather detailed information. The interview procedure followed a sequence of questions categorized into two sections.

In conducting the research, the data collection process followed a structured approach outlined in the interview guide. The first section of the guide focused on gathering general information about the companies involved in the study. This initial phase aimed to identify the capacity of the sample and included four questions, one closed-ended and three open-ended. Participants were asked about their company name, facilities, employee numbers, and focus areas.

Moving on to the second section of the interview guide, attention shifted to exploring the current usage of CAD/CAM technology within the footwear industry. This section was divided into three sub-sections: A, B, and C. Section A delved into CAD-related inquiries, posing nine questions (six closed-ended and three open-ended). These questions covered aspects like

awareness of CAD, usage patterns, applications, and barriers to implementation.

Section B of the guide focused on CAM-related topics and also featured nine questions, comprising a mix of closed-ended and open-ended queries. Participants were asked about their familiarity with CAM, current usage, applications, and challenges faced in its adoption.

Finally, Section C honed in on participants' perspectives regarding the proposed CRC. This section sought to gauge opinions on the feasibility and potential impact of such a facility within the industry. It comprised five questions, four closed-ended and one open-ended, exploring aspects like perception of the CRC, preferred location, and management preferences. Throughout the interview process, a combination of open and closed-ended questions was used to ensure comprehensive data collection. Probing questions were employed to delve deeper into participants' responses and gather detailed insights into the various aspects under investigation.

Unstructured Interviews

Data was gathered through interviews with a sample of experts (n_y=4) to solicit their perspectives on the industry, aiming to establish benchmarks for the CRC and validate information obtained from semi-structured interviews. The average duration of an interview was 55 minutes. Experts were cooperative and willing to share their insights, with no rejections recorded. Each participant viewed their contribution to the survey as a responsibility.

Initially, participants were provided with an introduction, after which questions were posed one by one, loosely following an interview guide. While a guide was in place, the interviews allowed for flexibility to accommodate expert comments. All interviews were recorded for accuracy.

The interviews focused on eliciting expert opinions on five distinct issues. While one question involved rating satisfaction on a scale of 1 to 3 for presently available common/general facilities, the remaining questions were open-ended. These questions covered topics such as main challenges in the SME footwear industry, needed assistance for its development, views on the proposed CRC, and suggestions for enhancing the SME footwear industry.

Data Analysis

Following the semi-structured and unstructured interviews with industry participants, data analysis commenced. Audio-recorded interviews provided the primary data source, which was then transcribed and coded. Through this coding process, themes emerged, enabling a deeper understanding of the insights shared by participants.

Particularly, the data collected during the general information section of the interviews played a crucial role. This data was instrumental in identifying and validating the representative nature of the sample. By analyzing this information, we could justify the selection of participants and ensure that the insights drawn from the interviews were reflective of the broader industry landscape.

Justification of sample

The data obtained from the first section of the interview guide, pertaining to organizational

capacity based on the number of employees, was compiled into a single spreadsheet for analysis. Figure 1 illustrates the distribution of organization capacity based on the number of employees.

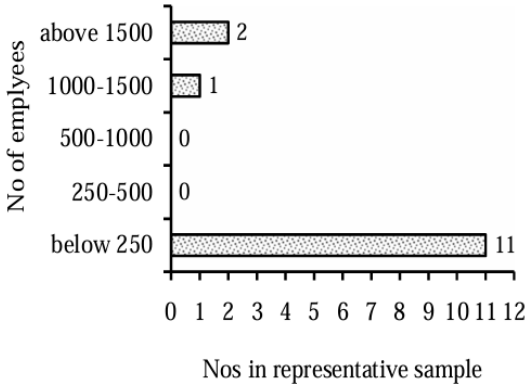

Figure 1: Organisation capacity based on number of employees

The analysis reveals that 79% of the sample reported having below 250 employees, indicating a strong correlation with the target population and suggesting that the sample is representative. Regarding capacity based on areas engaged, Figure 2 illustrates that the majority of organizations in the sample are involved in leather cutting and shoe soles manufacturing (including insoles, outer soles, and upper soles). Interestingly, according to IDB statistics (IDB, 2007), Sri Lanka has only two last design/manufacturing firms, and this sample includes just one. Similarly, there is only one shoe machinery design/manufacturing firm in Sri Lanka (IDB, 2007), and this firm is also represented in the sample.

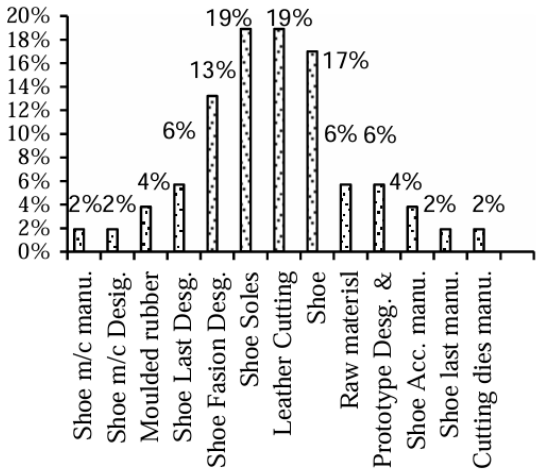

Figure 2: Sample capacity based on areas engaged

Analysis from section A, B and C of interview guide

Algorithm 1 : Analysis of closed-Ended question.

1. Select the answer from the closed-ended question.
2. If the answer is from an SME;
   - Select the SME column of the result table and type "A"
     Else , if the answer is from a Large Enterprise(LE);
   - Select the relevent sub-column (r_{ni}) in the result table and type "A".
3. Select the relevant sub-column (r_{ni}) in the result table and type "A", where:
   - n is the number of available options for the answer (1, 2, 3, ..., 10).
   - i is the number of SMEs in the sample (1, 2, 3, ..., 11).

4. Code "1" in the relevant sub-column (r_{ni}).
5. Calculate the sum of the relevant sub-column $\sum r_{ni}$.
6. Consider $\sum r_{ni}$ as a fraction of $\sum ni$ or $\sum nj$, where:
   - $\sum ni$ represents the total number of responses from SMEs (11 in this case).
   - $\sum nj$ represents the total number of responses from LEs (3 in this case).
7. Calculate the percentage of $\sum r_{ni}$ / 11 for SMEs or $\sum r_{ni}$ / 3 for LEs:
   - For SMEs: Calculate $\left(\frac{\sum r_{ni}}{11}\right) \times 100\%$.
   - For LEs: Calculate $\left(\frac{\sum r_{ni}}{3}\right) \times 100\%$.

This algorithm provides a systematic approach to analysing the responses to closed-ended questions in the semi-structured interviews, allowing for the calculation of percentages to understand the distribution of responses among SMEs and Large Enterprises.

Table 1: Fields used for data recording of algorithm 1

Particip ant No.	**SME**					**LE**				

Algorithm 2: Analysis of Open-Ended Questions: This algorithm offers a systematic approach to analysing responses to open-ended questions during semi-structured interviews. It entails categorizing responses as either from Subject Matter Experts SMEs or LEs and recording them in a result table accordingly.

1. Begin by selecting the answer to the open-ended question.
2. If the answer originates from an SME, mark "B" in the SME column of the result table.
3. If the answer comes from a Large Enterprise, mark "B" in the LE column of the result table.
4. Record the categorized response.

This method simplifies the process of analyzing diverse responses, facilitating clearer insights into the perspectives of SMEs versus those of Large Enterprises.

Analysis of Data Elicited Through Unstructured Interviews

The data collected from unstructured interviews was compiled into a unified spreadsheet. Subsequently, the data was organized based on the corresponding question numbers, ensuring that responses from each expert to the same question were grouped together to create a comprehensive pool of answers for each question.Following the compilation of answer pools for each question, common themes or patterns in the responses were identified, considering the similarity in meaning and context.

To assess experts' satisfaction with the existing facilities in the SME footwear industry, a coding system was employed: poor satisfaction was coded as 1, moderate satisfaction as 2, and high satisfaction as 3. The overall satisfaction level was then computed and the data was presented in tabular form.

Results & Discussion

Status of CAD Usage

Figure 3 illustrates the utilization of CAD technology within both SMEs and LEs in Sri Lanka's footwear industry. As anticipated, CAD usage is notably higher among LEs compared to SMEs. Remarkably, 82% of SMEs reported no utilization of CAD whatsoever.

Additionally, the study found that SMEs primarily employ CAD for pattern grading and drawing preparation, with a focus on part drawings, particularly using commonly available software such as AutoCAD.

Interestingly, all participants from LEs and 82% of those from SMEs expressed a willingness to incorporate CAD into their facilities, recognizing its potential benefits for the industry's advancement.

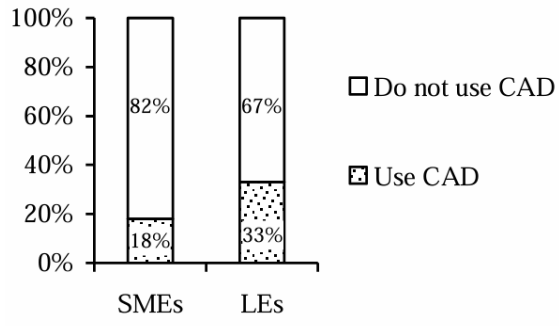

Figure 3: CAD usage of the Sri Lankan footwear industry

Recognizing the significance of understanding stakeholders' awareness of CAD within the footwear industry, it is crucial to note the findings. Figure 4 indicates that nearly all LEs demonstrate awareness of CAD applications, with close to 100% acknowledging its relevance. However, among SMEs, the awareness figure stands at 82%. This discrepancy underscores the need for targeted efforts to enhance CAD awareness and adoption within SMEs to ensure equitable technological advancement across the industry.

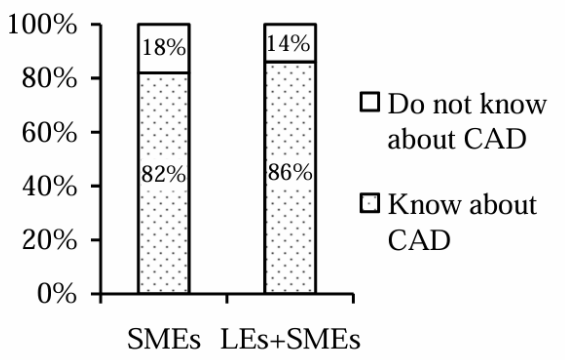

Figure 4: Awareness about CAD and its up to date application

The existence of 18% of SMEs lacking awareness of CAD applications poses a potential challenge to the introduction of CAD within these establishments. Notably, while some SMEs demonstrated awareness of CAD applications, they struggled to name specific computer application packages available.

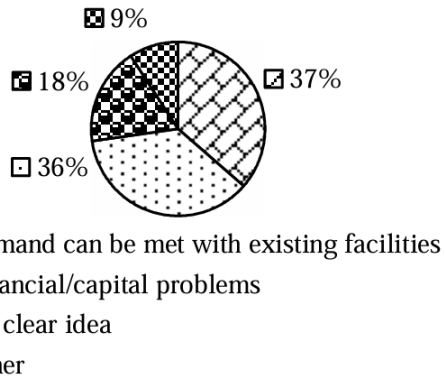

Figure 5: Reasons for not introducing CAD, out of the SMEs that are willing to introduce CAD

Despite the willingness of 100% of LEs and 82% of SMEs to introduce CAD into their facilities, a clear reason for the reluctance of the remaining 18% of SMEs to adopt CAD is not evident. However, findings indicate that 36% of them cited financial/capital resources as the primary barrier (refer to Figure 5).

The largest segment, comprising 37%, indicated that they believe the current demand could be handled using existing facilities. However, this perspective suggests a reluctance to expand production capacity, which ultimately hampers the industry's overall progress. Interestingly, the reasons provided by LEs regarding this issue exhibit only a slight variance from those of SMEs (refer to Figure 5).

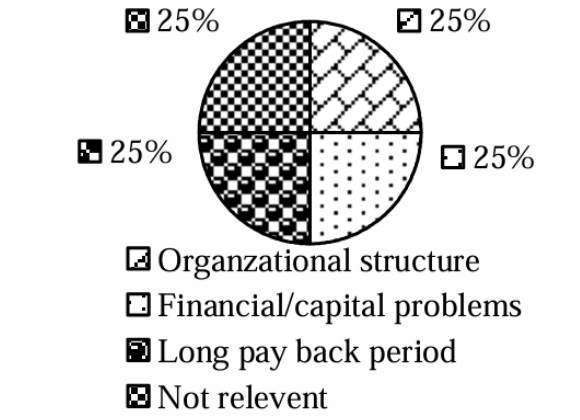

Figure 6: Reasons for not introducing CAD, out of the LEs that are willing to introduce CAD

LEs 25% expressed that introducing CAD is irrelevant due to the fact that their designs are handled by their parent companies located in other countries. Another 25% cited organizational structural issues as a hindrance. Such structural problems can impede decision-making processes, particularly within private sector industries, making it challenging to address. However, it's worth noting that professionals within the organization have the responsibility to propose productivity-enhancing measures to management as part of their professional duties.

Similar to SMEs, 25% of LEs also face financial and capital investment challenges associated with implementing CAD. While this figure is lower compared to SMEs, it remains a significant concern. Additionally, another 25% of LEs mentioned the long payback period associated with CAD investment, indicating a direct correlation with financial considerations. Consequently, it's evident that capital investment emerges as the primary barrier for both LEs and SMEs.

During interviews, participants were asked about the barriers they anticipated when introducing CAD. Table 2 provides a breakdown of these anticipated barriers as perceived by the respondents.

Table 2: Barriers to implement CAD

SMEs	LEs
Financial problems/Capital	Financial problems/Capital
Lack of O&M staff	Lack of resource personnel for CAD
Employee training	Employee training
Problems with technology transfer	
Payback period	
Human resource	

Once again, both SMEs and LEs identify

financial constraints, particularly related to capital investment, as a significant barrier. In such a scenario, the establishment of a common facility may prove beneficial, alleviating economic burdens for individual entrepreneurs. Conversely, providing separate funding for each entrepreneur is impractical.

Another barrier highlighted by SMEs is the lack of operation and maintenance staff, while LEs express a similar concern regarding the shortage of resource personnel. This shortage of skilled personnel is a common challenge across industries in Sri Lanka. The proposed CRC could address this issue by providing trained personnel who can offer consultation during the initial stages of CAD implementation. Additionally, the CRC could facilitate the training of resource personnel, given the availability of necessary facilities.

SMEs also anticipate problems with technology transfer as another barrier, underscoring the challenges associated with adopting new technologies. Furthermore, the long payback period is cited as a barrier by SMEs, once again highlighting the financial constraints prevalent in the industry.

Status of CAM usage

Figure 7 presents the utilization of CAM within the LE sector of the footwear industry. Notably, 67% of LEs reported no usage of any CAM applications in their facilities. Interestingly, the percentage usage of CAD and CAM among LEs is exactly the same, standing at 33%.

However, it's important to highlight that CAM applications are entirely absent in SMEs, as indicated by the 0% usage depicted in Figure 7. When considering the footwear industry as a whole (LEs+SMEs), CAM is utilized by only 7% of the industries. This data underscores the relatively low adoption of CAM technology within the Sri Lankan footwear industry.

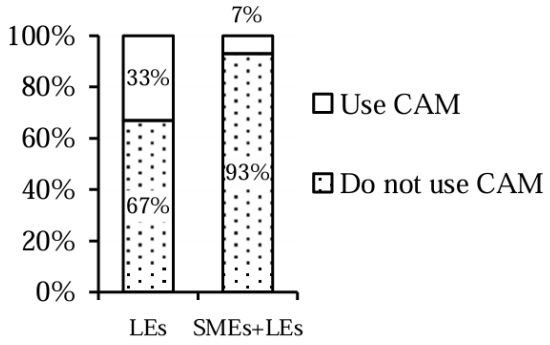

Figure 7: CAM usage in Sri Lankan LE footwear industries

The situation regarding CAM exhibits a slight deviation compared to CAD in this assessment. Specifically, 27% of SMEs within the footwear industry expressed reluctance to introduce CAM in their facilities, as indicated in Figure 8. This suggests a noteworthy portion of SMEs hesitant to adopt CAM technology, potentially impacting its overall integration within the industry.

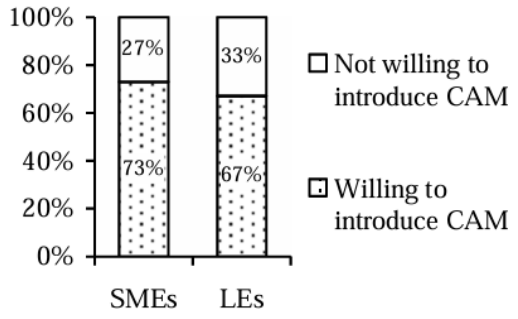

Figure 8 provides insight into the willingness of the footwear industry to introduce CAM.

Among LEs, the situation differs significantly, with 67% expressing willingness to adopt CAM in their facilities.

Expanding the scope to encompass the entire footwear industry, Figure 9 reveals that a substantial 79% are open to introducing CAM applications. This indicates a generally favourable attitude toward CAM adoption within the industry, particularly among both LEs and SMEs combined.

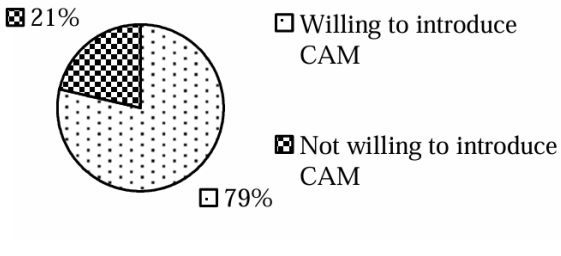

Figure 8: Footwear industry's willingness to introduce CAM

According to the study sample, 100% of LEs are aware of CAM and its applications, but in the case of SMEs, 64% lack awareness of CAM applications available locally/globally (Figure 10). Despite this, 50% of the footwear industry as a whole is indicated that the existing facilities were aware of CAM (Figure 10). Additionally, inquiries were made regarding awareness of CAM packages and machines. A notable 93% of individuals within the industry lacked knowledge about available CAM packages/machines, while the remaining respondents were aware of CAM packages utilized at the Footwear Design and Development Institute (FDDI) in India.

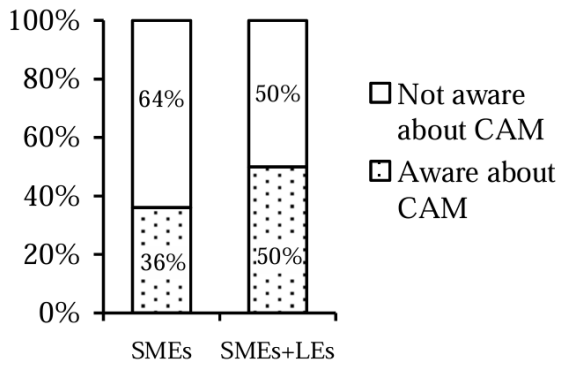

Figure 9: Footwear industry awareness about CAM

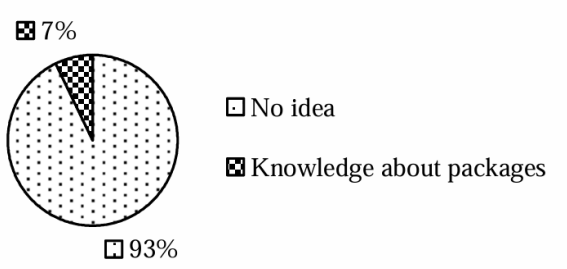

Figure 10: Awareness about available CAM packages

Among SMEs, 36% cited financial difficulties as the primary obstacle to introducing CAM applications in their facilities. Additionally, another 46% indicated that the existing facilities were sufficient to meet demand (Figure 12).

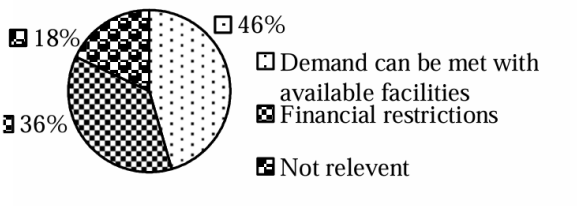

Figure 11: Reasons of not yet introducing CAM in SME footwear industry financial restrictions

Failing to plan for continuous increases in production capacity could pose challenges in remaining competitive within the market. Enhancing facilities is crucial for expanding production capacity. While present facilities may suffice for current production levels, it's imperative to devise a capacity improvement plan for future sustainability. Similar to CAD implementation, LEs identified organizational (structural) problems (25%), long payback periods (25%), and capital investment (25%) as barriers to CAM implementation, as depicted in Figure 13.

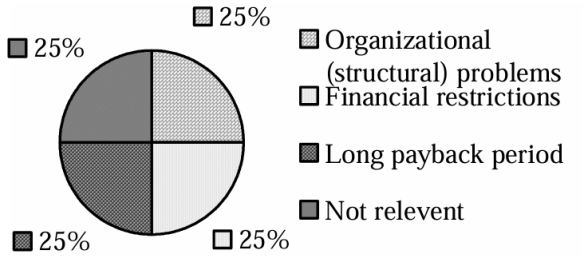

Figure 12: Reasons of not introducing CAM in LE footwear industry

Figure 14 illustrates the barriers anticipated by participants when attempting to implement CAM in SMEs. Similar to the challenges faced in introducing CAD, financial constraints emerge as the primary burden, accounting for 66% of SMEs. Additionally, 10% of SMEs anticipate employee training to pose a barrier. Other barriers expected by SMEs include the lack of operation and maintenance staff, technology transfer issues, long payback periods, and human resource constraints, each representing 6% of SMEs. These challenges collectively underscore the complexities involved in adopting CAM technology within SMEs in the footwear industry.

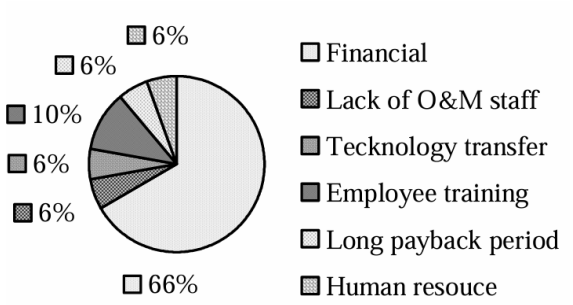

Figure 13: Barriers would have to face when implementing CAM in SME footwear industry

Figure 15 indicates that 33% of LEs identify employee training as a barrier to be addressed when implementing CAM. On the other hand, 17% of SMEs cite financial resources as a barrier, while another 17% mention the lack of resource personnel as a challenge.

Interestingly, 33% of LEs expressed uncertainty about the barriers they might encounter. This diverse range of perceived barriers highlights the multifaceted nature of implementing CAM technology within both large and small enterprises in the footwear industry.

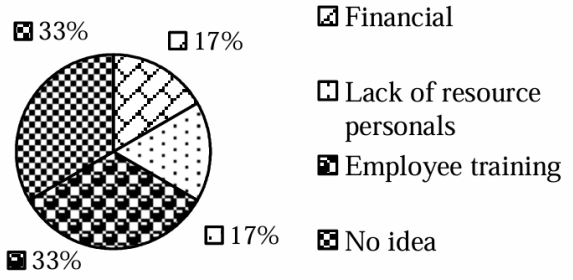

Figure 14: Barriers would have to face when introducing CAM in LE footwear industry

Experts view on SME footwear industry

Based on the results gleaned from the analysis of responses obtained through unstructured interviews with experts, a comprehensive overview of SMEs was distilled. The summarized view is as follows:

Primary challenge: High production costs were consistently highlighted as a major issue by experts, necessitating a deeper investigation into its root causes. Typically, these costs stem from various factors including raw material expenses, accessory costs, labour expenditures, and logistical challenges.

Raw material scarcity: The dearth of raw materials poses a significant challenge, particularly impacting the leather shoe industry. The cost of raw materials remains high, compounded by insufficient availability. In particular, the scarcity of finished leather emerges as a primary constraint, with locally processed leather failing to meet industry demands in terms of both quantity and quality.

Competition from low-priced imports: Imported footwear from countries such as China, Vietnam, Thailand, and Hong Kong pose stiff competition, as their lower production costs, attributed to advanced technology and economies of scale, undercut local prices.

Environmental regulations: Stringent environmental regulations present challenges for leather shoe manufacturers, particularly in tanning and leather processing. Recent adverse publicity surrounding pollution from these industrial activities threatens the supply of finished leather, potentially leading to increased costs.

Technological limitations: Insufficient mechanization and a lack of modern technology result in subpar product quality. Inadequate product development and design facilities, especially in grading and pattern cutting, are predominantly manual processes, hindering efficiency and innovation.

The experts were eager to provide insights into the requirements of a CRC for the SME footwear industry. Their feedback included the following key information:

- CAD/CAM system for pattern cutting: Manual methods currently consume more time and result in increased waste. Implementing CAM systems with nesting facilities can minimize material wastage, particularly for cutting complex patterns.
- CADCAM system for pattern grading: There is a need to reduce the time required for grading patterns, which can be achieved through the implementation of CAD/CAM systems.
- CNC die manufacturing machine (CNC milling machine): Streamlining the process of manufacturing upper and lower patterns through CNC die manufacturing machines is crucial. Current methods are time-consuming, and advancements in technology can significantly improve efficiency.
- Prototype development machine: Specifically, for the fashion shoe industry, a prototype development machine is essential to facilitate rapid prototyping and innovation.

- Testing facility: Establishing a testing facility for material and finished goods testing is vital. This facility should offer testing services at a low cost to support the quality control process.

Figure 16 depicts the satisfaction levels of experts regarding the presently available facilities for SMEs. Notably, lower satisfaction ratings are observed for funding and technical assistance related to product development. In light of these findings, implementing a CRC emerges as a potential solution to address these challenges.

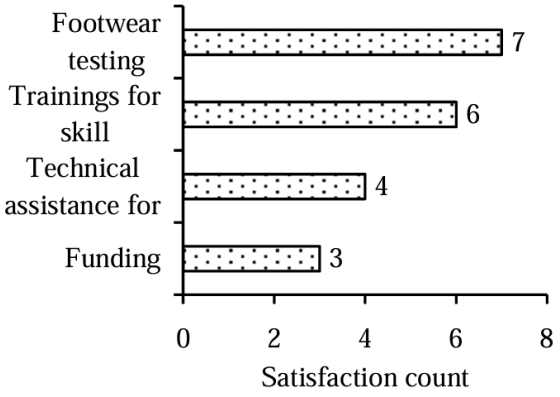

Figure 15: Experts satisfaction of available facilities to SMEs

The experts provided several independent proposals and ideas to foster the development of the SME footwear industry:

- Encourage active engagement: Responsible entities such as the Government, EDB, and IDB should actively listen to the issues faced by SMEs in the industry.

- Expand international presence: Facilitate the entry of SMEs into international markets to broaden their reach and opportunities.

- Enhance training facilities: Increase the availability of training facilities to elevate skill and knowledge levels within the industry.

- Empower unemployed youth: Provide training opportunities for unemployed youth to enhance the skillset of the available labour force for the footwear industry.

- Embrace new technology:Introduce new technologies aimed at reducing production costs and improving efficiency.

- Advocate for policy change: Advocate for a shift in the government's attitude towards the footwear industry to create a more supportive environment.

- Encourage export promotion: SMEs should actively promote export production to expand their market presence and drive growth.

Proposed Common Resource Centre

The objective of this research is to propose comprehensive solutions and innovative tools aimed at enhancing the technological capabilities of potential SMEs in the footwear and auxiliary industry. This will be achieved through the establishment of a CRC, which will offer services to the industry. The primary outcome of this study is a proposal containing recommendations based on input from stakeholders and experts, focusing on the provision of CAD/CAM services, particularly to potential SMEs. Implementation of these

services is expected to reduce production costs and empower SMEs.

While the concept of CRC is not new globally, with India already having established several centers to support the footwear industry, there are significant opportunities for the industry, especially potential SMEs, due to the proposed CRC.

The proposed CRC would offer a range of services and resources to support the development of the footwear industry, particularly for SMEs:

- Common facility services equipped with modern machinery and manufacturing technology, including CAD/CAM capabilities.
- Testing facilities and technical consultancy services to ensure product quality and innovation.
- Access to relevant information on the footwear industry, facilitating informed decision-making and market understanding.
- Support for product research and development activities to foster innovation and competitiveness.
- Technical assistance to facilitate the establishment of independent footwear businesses.
- Personnel empowerment initiatives tailored to the needs of the footwear and allied industries.
- Skills enhancement programs aimed at updating and upgrading industry-specific skills.
- Establishment of linkages with footwear-related industries, trade associations, and organizations to foster collaboration and networking opportunities.
- Provision of a suitable foundation for higher education and advanced studies in the field of footwear.

The location of the proposed CRC holds significant importance as it directly impacts supply chain management and logistics. Typically, common facility locations are determined based on existing factory locations. During interviews, respondents were queried about their preferences regarding the CRC's location, with predefined options including university, technical college, government premises, private organization, and existing footwear training centers or other independent facilities. The results, depicted in Figure 17, illustrate SMEs' preferences regarding the location of the proposed CRC.

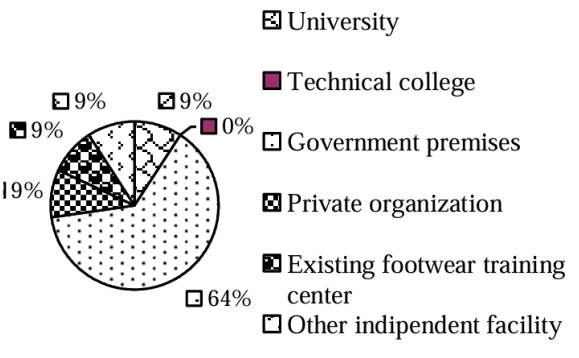

Figure 16: SMEs willingness on location (in which premises) of CRC

Figure 18 highlights the preference for the

location of the CRC by city. Colombo city and Kurunegala emerge as the top preferences compared to other cities.

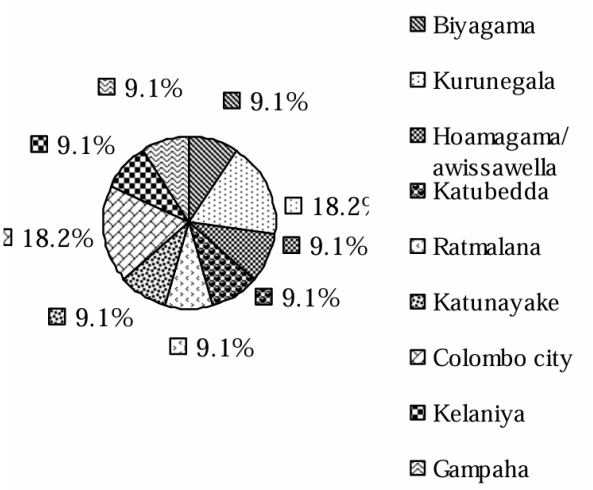

Figure 17: SMEs willingness on location (in which city) of CRC

The management of the CRC carries significant responsibility, as the efficiency and effectiveness of its services directly impact its customers. Adequate funding for maintenance and system upgrades is crucial for sustained operations. However, it's common for facilities to face funding shortages after establishment, hindering operational and maintenance activities.
Perceptions about the management of the proposed CRC were gathered through interviews, offering pre-determined management options. The footwear industry's perception on this matter is outlined below.

- Government authority management: Accepted by 43% of respondents.
- Semi-governmental management: Accepted by 29%.
- Private sector management: Accepted by 14%.

Regarding SMEs, 46% accept management by a government authority, while 36% and 9% accept semi-governmental and private sector management, respectively. Notably, none of the SMEs expressed willingness for university management. However, it's vital to strengthen the link between academic institutes and the industry for national development, offering significant benefits to both sectors. Expert reviews were instrumental in determining the services and facilities required from the CRC. Through unstructured interviews, experts disclosed the following requirements:

- CAD/CAM for pattern cutting and pattern grading
- CNC die manufacturing machine
- Prototype development machine for the fashion shoe industry
- Affordable testing facility for material and finished goods testing
- CAD/CAM training for employees

In alignment with these requirements, the vision of the CRC is to become the premier demand-driven institute providing CAD/CAM facilities for the Sri Lankan footwear industry to effectively address global competitive challenges. The mission is to deliver demand-driven CAD/CAM facilities, industrial R&D, and internationally competitive services to stimulate rapid industrialization for the benefit of the Sri Lankan footwear industry. Achieving this mission requires the utilization of dedicated and technologically adept professionals equipped with the right software and machinery.

Universities and technical institutions can offer technical assistance to bridge the technology gap, as the current understanding of CAD/CAM technologies among local industries is limited (Fernando et al., 2005a). To meet the identified requirements, the concept of the CRC is designed to encompass the following features, as depicted in Figure 19:

- CAD/CAM facility: Dedicated to providing CAD/CAM services for pattern cutting, pattern grading, and other related processes.

- Testing and laboratory services division: Equipped to offer comprehensive testing facilities for material and finished goods testing, ensuring quality standards are met

- Training and skills development division: Focused on providing CAD/CAM training programs to enhance the skills of industry personnel.

- Research and development division: Established to facilitate research activities related to the footwear industry, fostering innovation and advancement.

In accordance with the requirements, the concept of the CRC is developed to have the features illustrated in Figure 19. It is proposed to have a CAD/CAM facility, testing and laboratory services division and a training and skills development division. In addition, a research and development division are proposed to facilitate related research.

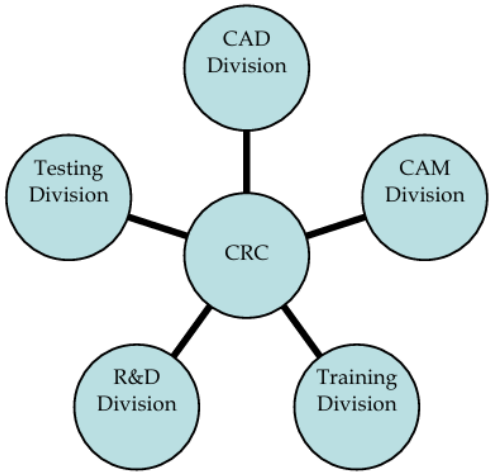

Figure 18: Schematic outline of proposed CRC

Conclusions

The utilization of CAD/CAM in both SMEs and LEs appears to be inadequate, with a corresponding lack of awareness within the SME footwear industry. However, there is considerable willingness among SMEs to introduce CAD/CAM into their facilities, averaging at 77.5%. Financial constraints were cited as a significant barrier by 36% of SMEs and 25% of LEs for not implementing CAD/CAM. Other obstacles identified by SMEs include a lack of operation and maintenance staff, employee training issues, technology transfer challenges, long payback periods, and human resource constraints.

Given these barriers, the CRC concept emerges as a primary strategy to address the challenges faced by potential SMEs in the industry. With unanimous support from SMEs, LEs, and industry experts, the CRC presents a viable solution to overcome these obstacles. Harnessing the industry through the CRC concept is feasible, as it aligns with the industry's collective vision for advancement.

However, it's worth noting that this study was conducted during the 2007-2009 period in Sri Lanka. Therefore, conducting further research considering the post-pandemic economic situation of the country would be beneficial to map the present scenario of the footwear industry. Such a study could provide updated insights into the industry's current challenges, opportunities, and needs, enabling stakeholders to make informed decisions and strategies.

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