CRITERIA 3

RESEARCH, INNOVATIONS AND EXTENSION

3.3.1 Number of research papers published per teacher in the Journals notified on UGC website

3.3.1 Number of research papers published per teacher in the Journals notified on UGC website during the last five years

2018-19

SL No	Title of Paper	Name of Author
1	An Efficient Citrus Canker Detection Method Based On Contrast Limited Adaptive Histogram Equalization Enhancement	Ms Shoby Sunny
2	Explaining user acceptance and usage of social networking sites: the role of trust, social connect connectedness and visibility in extending UTAUT2	K.Praveena, Sam Thomas
3	Integrated Technology for Producing Eco-friendly. Coconut Biofuel through Cost Effective Way	C. Mohankumar, Salini Bhasker and Harish M
4	"Coconut Neera - A Vital Health Beverage from Coconut Palms: Harvesting, Processing and Quality Analysis"	M Chinnamma
5	An investigative study on Export Performance of Gems and Jewellery in India An investigative study on Export Performance of Gems and Jewellery in India	Dr. Reshmi A. Rajan
6	The Consumer Experience on geographical indicators and its impact On purchase decision: an empirical study	Dr. A. Thangaraja

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International Journal of Applied Engineering Research ISSN 0973-4562 Volume 13, Number 1 (2018) pp. 809-815

An Efficient Citrus Canker Detection Method based on Contrast Limited Adaptive Histogram Equalization Enhancement

Shoby Sunny[1] and Dr. M. P. Indra Gandhi[2]

[1]Research Scholar, [2]Assistant Professor,
Depart of Computer Science, Mother Teresa Women's University,
Kodaikanal, Tamil Nadu, India.
ORCIDs: [1]0000- 0002-1139-0089, [2]0000-0001-6782-5857

Abstract

Plant leaf disease is one of the critical causes for heavy loss of yield that reduces quantity and reduces quality of the agricultural product. Citrus plants such as lemon are mainly affected by citrus canker disease which affects the fruit production of the plants. Early canker disease identification is one of the challenging solution for increasing the plant production. This paper aims to identify and classify the canker disease accurately from the affected leaf images by adopting image processing techniques to detect plant leaf diseases from digital images. The proposed approach involves two stages to improve the clarity of leaf images. The primary stage uses Contrast Limited Adaptive Histogram Equalization (CLAHE) in pre-processing step which improves the contrast level of disease affected leaf image, segment the region of interest using K-mean Clustering and texture feature extraction using statistical GLCM. The second stage by adopting the Support Vector Machine classifier to detect the canker leaf image and implements these methods in lemon citrus canker disease detection. Experimental results show effective accuracy detection and reduced execution time of canker disease detection.

Keywords: Citrus Canker Disease, Image Processing Techniques, Histogram Equalization, Gray-Level Co-Occurrence Matrix and Support Vector Machine.

INTRODUCTION

The agricultural land mass is more than just being a feeding sourcing in today's world. Indian economy is highly dependent of agricultural productivity. The occurrence of the disease on the plant result in substantial loss in both quality as well as the quantity of agricultural product. This can create the negative impact on the countries whose economies are primarily dependent on the agriculture. Hence the detection of the disease in plants is significant to avoid the financial loss.

In recent years, the leading severe disease is citrus canker and it is considered as one of the major disease among plants. Citrus plants such as lemon, orange are a long duration crops and traditional medicine plants are affected by a canker disease which appears as bacterial spot. The proposed approach considers lemon leaves for classification of citrus canker disease because of high commercial cultivation crop. Lemon is an important source of vitamin C and contains flavonoid compounds that have distinct antioxidant and anti-cancer properties [2].

Citrus canker is a bacterial disease that affect the premature leaves and fruits of citrus plants. Initially, the infected leaves have some white spongy spots and that will turn to grey or brown later. The spots consist of oily margins or yellowish ring (lesions), which can appear on both sides of the leaves shown in figure 1. This disease can be detected by the appearance of lesion on groves, stems and leaves. The symptoms are appear as yellowish spots or halos on leaves that gradually enlarge to 2 – 4 mm dark brown pustules [7].

Figure 1 Citrus Canker Lesions in leaf and fruit

This citrus canker disease is caused by the bacterium Xanthomonas Axonopodis PV. Citric (XAC). The infection of citrus canker results in defoliation, dieback, tarnished fruit, reduced fruit quality, premature leaf and fruit and at last the trees will produce no fruits. Citrus canker is highly infectious and can be spread rapidly by wind, rain, landscaping equipment, people work in field, moving infected or exposed plants or plant parts and it is difficult to eradicate. Detecting citrus canker at the early stage is the key to control and spreading of this disease.

Digital image processing [9] and image analysis technology based on the advances in real time applications such as microelectronics, computers, medicine and biology and it able to circumvents the problems. In this paper a new model for enhancement of pre-processing image with efficient contrast and to predict the canker disease in citrus plant (lemon) by classifier is implement. This approach aims to use contrast enhancement techniques [21] to enhance the image quality and to classify the citrus canker affected leaf by Support Vector Machine classification. This system which can provide more accurate results related to the identification and classification of

disease. From an innovation perspective, the research contributions are as follows,

a) To enhance the quality and contrast of citrus leaf image by adopting a Contrast Limited Adaptive Histogram Equalization (CLAHE) enhancement techniques.

b) Presenting a framework for citrus canker diseases detection in citrus lemon leaf classification by implementing Support Vector Machine.

The remainder of this paper is organized as follows; Section II reviews briefly explains about the image processing techniques employed in plant disease detection, various classifiers used for citrus detection and limitations are identified. Section III presents the image processing techniques for canker detection in citrus leaf with classifiers. Experimental Results of the proposed technique are presented in Section IV. Finally, Section V concludes the paper.

RELATED WORKS

Various techniques of image processing and classifiers techniques have been developed for detection of canker diseases occurring on plant leaves, stems, lesion etc. Yue et.al [1] introduce intrinsic image decomposition priors into deterioration models for contrast enhancement named as Contrast Limited Adaptive Histogram Equalization (CLAHE). To enhance the pictures by modifying the decomposed enlightenment layer to improve under (finished) uncovered pictures. The histogram-based strategies image contrast by altering histogram appropriations. The two fundamental modules are intrinsic image decomposition and illumination adjustment are utilized to improve the quality of image.

Thangadurai and Padmavathi [7] presented a Computer vision image enhancement utilizing hereditary algorithm in plant leaves infection. Plant leaves diseases identification is utilized caught pictures for diseases analyzes and detection. Hereditary algorithm such as Genetic algorithm is utilized to discover the optimal solution and used to tackle issues in disease detection. In which grayscale pictures are anything but difficult to process and execute for different applications since they have better clarity and suited for examination than RGB pictures Histogram equalization out is utilized to increase the images clarity. The resultant images accomplish the improvement in image quality.

Menukaewjinda *et al.* [14] developed an Artifcial Neural Network (ANN) i.e. Back Propagation Neural Network (BPNN) for grape leaf color extraction with complex background. The integration of Modified Self-Organizing Feature Map (MSOFM) and Genetic Algorithm (GA) are implemented which provide automatic adjustment in parameters for grape leaf disease color extraction.

The maize disease image recognition of corn based on Back Propagation (BP) networks effectively developed by Song Kai *et al.* [13] YCbCr color space technology is adopted to segment disease affected spot, Co-Occurrence Matrix (COM) spatial gray level layer is used to extract disease spot texture feature, BP neural network has been used to classify the maize disease. The applications of K-means clustering as well as BP neural networks are estimated for clustering and classification of diseases.

Gavhale et.al [2] presents an image processing technique for detection of unhealthy region of Citrus leaf. There are four sorts of citrus diseases specifically Citrus ulcer, Anthracnose, Overwatering and Citrus greening. The proposed system includes image acquisition is the initial step for capturing picture by computerized camera to make database. Color space conversion and image enhancement is done in picture pre-preparing. Discrete cosine transform domain is utilized for image enhancement. YCbCr color system and L*a*b* color space are decided for color space transformation. In feature extraction statistical technique, utilizing Gray-Level Co-Occurrence Matrix (GLCM) to see measurements, for example, contrast, energy, homogeneity and entropy using gray crops enhancement.

Mokhtar *et.al* [3] present image processing technique for Tomato leaves diseases detection. In pre-processing stage a few strategies are applied for image enhancement, smoothness, remove noise, picture resizing, image isolation, and background removing. Gabor wavelet change and Support vector machine are implemented for identification and classification of tomato diseases. In feature extraction stage with the assistance of Gabor wavelet change include vectors are acquired for next classification stage. In classification phase, Support Vector Machine (SVM) is prepared for distinguishing the classification of tomato diseases.

Mitkal et.al [4] introduced an image processing technique for Sugarcane leaf detection disease. In preprocessing steps RGB images are converted to grayscale and unwanted part of data from the images is removed. Segmentation fins the diseased part of given image which contains green pixels and potentially infected area. Linear SVM, Nonlinear SVM and Multiclass SVM are used in feature extraction for disease detection.

PROPOSED METHODOLOGY

Image processing [10] has play a terribly important role in agriculture field because of widely accustomed observe the crop disease with high accuracy. For classification and detection of plant disease, digital image method is extremely effective in providing better detection for characteristic diseases at its early stages. Image processing techniques [12] is applied on various applications which includes to detect plant leaf, stem, and fruit diseases and to find the edges, color of the affected area. This paper focused mainly to improve the image quality with greater clarity by CLAHE enhancement techniques [18] in pre-processing stages and to detect the canker disease by classifiers. The following image processing techniques steps are used to detect the disease and Support Vector Machine are applied to get optimal solution of the canker disease are shown in figure 2.

Image Acquisition

Image acquisition is the initial step for citrus canker detection. The canker disease affected citrus lemon leaf images are captured by high resolution digital camera and saved as image

processing supported format such as JPEG, TIF, BMP, PNG etc. The input captured image is then resized to 512 x 512 pixels.

Image Pre-processing

Image pre-processing is a second step of canker detection mainly it is used to improve the captured image data which suppress the distortions and also enhances the image features for further process that is more convenient to a human observer. Pre-processing step includes various techniques like image resize, filtering, morphological operations etc.

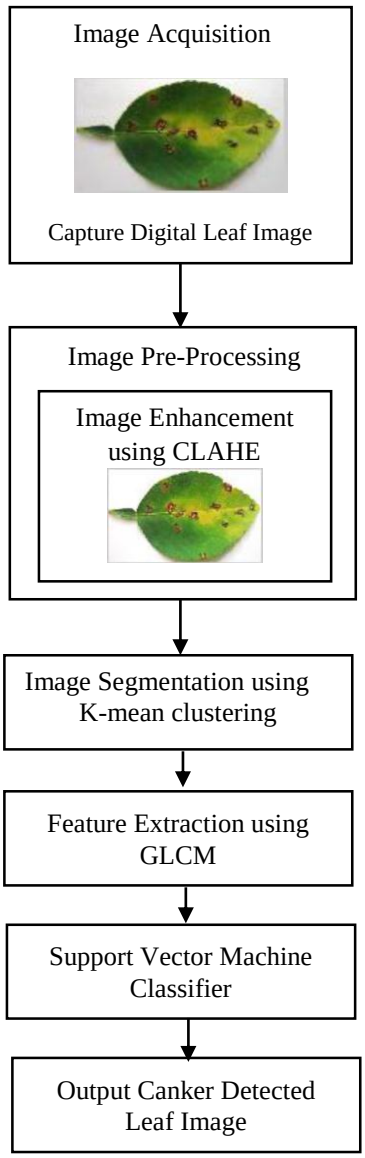

Figure 2 Flowchart for Citrus Canker Detection

The captured leaf images are resized to a fixed resolution. Since the images are captured from the fields, it contains some inevitable noises which are removed by filters such as Gaussian, median, Linear, Low pass, high pass filters etc., which will be selected depends upon the noise level of the images. Image pre-processing techniques includes image enhancement where the affected areas are enhanced with high quality. At first the damaged image should be pre-processed which reduce the effect made by the background.

Image Enhancement

The color images are observed blindingly different for human visual perception which computes the conscious representation. Image enhancement it is adopted to improve the interpretability, visibility and quality of the image. The mainstream enhancement methods are Histogram Equalization which distributes the intensities of the images by increasing image contrast from low to high. Histogram equalization [1] creates an output image with a uniform histogram which flattens and stretches the dynamic range of the intensity levels of the images due to its simplicity and effectiveness. However, it will change the brightness of the image and may result in highly contrast enhancement. To find the mapping for each pixel based on local (neighborhood) grayscale distribution in targeted image.

In some cases, the histogram equalization it not be desirable to transform very low-contrast images because of highly localized grayscale distribution. For this situation the mapping curve may include segments with high slopes, that two very close grayscales might be mapped to significantly different grayscales. This issue is resolved by limiting the contrast through histogram equalization [15]. HE faces certain constraints, such as brightness preservation, contrast limitation and weighted adjustment. The integration of this contrast limiting approach with the adaptive histogram equalization [16] results named as Contrast Limited Adaptive Histogram Equalization (CLAHE).

CLAHE

Contrast Limited Adaptive Histogram Equalization (CLAHE) has produced good statistical estimation results on medical, computer and real time applications [8]. This CLAHE is framed based on partition the targeted image to certain non-overlapping regions of equal sizes. For 512 × 512 images, the number of regions is randomly selected which is equal to 64 achieved by equally dividing the image by 8 in each direction. For an instance, the sample division is shown in figure 3. This partition results in three different groups of regions.

The first one is Corner Regions (CR) four sides of images. The second region consists of 24 regions, is the Border Regions (BR) includes all regions on the image border, excluding the corner regions. The last one consists of all the remaining 36 regions, as Inner Regions (IR). To improve the image enhancement at first, histogram for each region is calculated based on a limit for contrast expansion, a clip limit for clipping histograms. Then estimated histogram is redistributed in such a way that its height does not go beyond the clip limit. In this case, for each grayscale, number of pixels with that grayscale in the region is counted. Collection of these counts for all grayscales is referred to as histogram of that region.

Finally, Cumulative Distribution Functions (CDF) [8], is calculated for CLAHE grayscale mapping then the histogram equalization is obtained by using an estimation of the CDF. For each region the numbers of pixels and grayscales, are defined as

M and *N*, and if $h_{i,j}(n)$, for n = 0, 1, 2,..., N−1, is the histogram of (i, j) region, then an estimate of the CDF, which is scaled by (N − 1) for grayscale mapping, are represented as follows

$$f_{i,j}(n) = \frac{(N-1)}{M} \cdot \sum_{k=0}^{n} h_{i,j}(k) \quad n = 1,2..N-1 \qquad \text{---(2)}$$

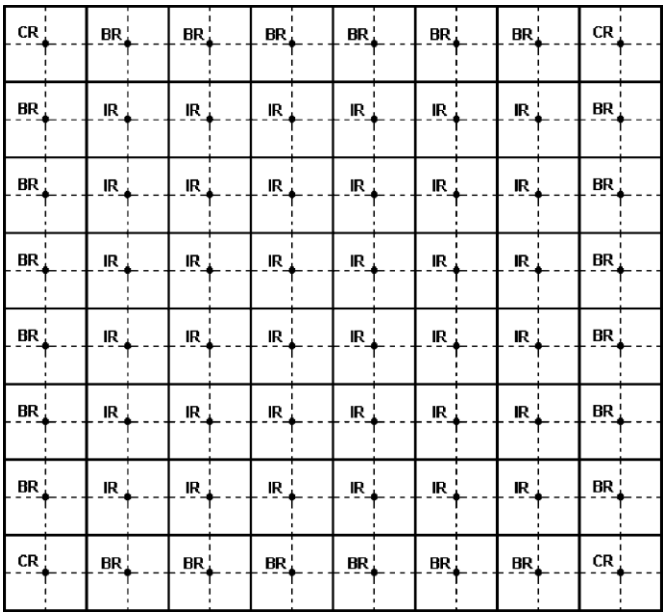

Figure 3 Structure of Leaf Regions in a 512 × 512 Square Image

This histogram function used to convert the given grayscale density function, approximately, to a uniform density function. In the CLAHE technique, each pixels are mapped by linearly combining the partition results from the mappings region of the four nearest regions. CLAHE formulation of histogram equalization for IR group is straightforward. However, for regions in CR and BR groups this formulation requires some special consideration. When the leaves images noises are removed, then by enhancement techniques the quality of the images will be improved are shown in figure 4. Finally the highly enhanced citrus leaf images are obtained. The next process is to extract leaf disease region in the image using image segmentation method.

Original Image **Enhanced Image**

Figure 4 Image Enhancement using CLAHE

Image segmentation

The citrus canker diseased leaves images are partitioned into multiple segments by using segmentation process. Segmentation is used to segment the interest disease affected portion of the leaves images. There are various techniques are used for image segmentation such as clustering methods, compression based methods, histogram-based methods, region growing methods, etc. In this system k-means clustering algorithm is used for the segmentation of image which is totally dependent on the features and characteristics of image.

In segmentation, image is divided into a small significant segment known as clusters [5]. K-means technique detects the clusters from the processed image. The input for k-means clustering image has *N* objects of citrus leaves are to be cluster (X_1, X_2, X_N) and *K* is the number of cluster. Output is the addition of dissimilar citrus leaves and finally diseased leaf portion is obtained. However, K-means clustering is used to separate the leaf image into different clusters if a leaf contains more than one disease. K-means clustering has good adaptability and also suitable for large set of information. At the end of the segmentation process, the diseased portions of the leaves are extracted.

Feature extraction

In plant diseases detection, each leaves have unique feature characteristics which play a fundamental role in classification of disease. In this approach, leaves image features include texture, color, shape are considered for disease detection. In this system by considering the texture portion which is the most significant features for image classification and retrieval. Here texture features of diseased leaf includes Contrast, Energy, Local homogeneity, Cluster shade and cluster prominence are computed by Gray-Level Co-Occurrence Matrix [7]. This method allows computing some statistics describing texture.

Gray-Level Co-Occurrence Matrix (GLCM) - GLCM is the statistical method of analytical texture which considers the spatial relationship of each pixels [2]. The GLCM characterize the texture leaf image by calculating the pixel occurrence in an image with specific values and in a specified spatial relationship. By creating a GLCM followed by extracting statistical measures from this matrix.

Contrast - It is the measure of pixel intensity contrast and its neighbor pixel of the target image. If the target image is equal to 0 the largest value of the image is obtained. It can be defined as

$$Contrast = \sum_{i,j=0}^{N-1} P_{ij}(i-j)^2$$

Energy - Energy is a measure of uniformity with squared elements summation in the GLCM, it lies in the range between 0 and 1. If the energy is 1 for a constant image then it can be represented as

$$Energy = \sum_{i,j=0}^{N-1} {P_{ij}}^2$$

Homogeneity - It is the measures of the closeness of the distribution of elements towards the diagonal in the GLCM and

lies in the range between 0 and 1. Homogeneity is 1 for a diagonal GLCM and it is defined as

$$Homogenety = \sum_{i,j=0}^{N-1} \frac{P_{ij}}{1+(i-j)^2}$$

Correlation - Correlation measures how correlate a pixel to its neighbor pixel over the whole image and lies between -1 and 1 [2].

$$Correlation = \sum_{i,j=0}^{N-1} P_{ij} \frac{(i-\mu)(j-\mu)}{\sigma^2}$$

where,

P_{ij} = Element i,j of the image

N = Number of gray levels

μ = mean value of all pixels in the relationships that contributed to the GLCM, it is calculated as:

$$\mu = \sum_{i,j=0}^{N-1} i\, P_{ij}$$

σ^2= variance of the intensities of all reference pixels calculated as:

$$\sigma^2 = \sum_{i,j=0}^{N-1} P_{ij}\,(i-\mu)^2$$

After the texture features extraction, find out the stage of the disease. According to the leaves color and result of texture features, the disease level can be identified.

Classifier

The Support Vector Machine (SVM) classifiers are adopted differentiate citrus leaf disease. SVM is used to classify disease on their texture feature. It constructs a hyper plane in a high dimensional space that can be used for classification. For given citrus leaves image a set of points belonging to either one of the two classes, an SVM finds a hyperplane having the largest possible fraction of points of the same class on the same plane. This separating hyperplane is called the Optimal Separating Hyperplane (OSH) that maximizes the distance between the two parallel hyper planes and can minimize the risk of misclassifying examples of the test set.

Given labeled training data as data points of the form

$$M = \{(x_1, y_1), (x_2, y_2), \dots\dots, (x_n, y_n)\} \quad \text{------(2)}$$

where y_n =1/-1, a constant that denotes the class to which that point x_n belongs. n=number of data sample. Each x_n is a p-dimensional real vector. The SVM classifier first maps the input vectors into a decision value, and then performs the classification using an appropriate threshold value. To view the training data, by divide (or separate) the hyperplane, which can be described as:

Mapping: $w^T.x + b = 0$

where w is a p-dimensional weight vector and b is a scalar. The vector w points perpendicular to the separating hyperplane. The offset parameter b allows increasing the margin. When the training data are linearly separable, select these hyperplanes so that there are no points between them and then try on maximizing the distance between the hyperplane. Found out that the distance between the hyperplane as 2/ |w|. To minimize |w|, need to ensure that for all i either

$$w.x_i - b \geq 1 \; or \; w.x_i - b \leq -1 \quad \text{------(3)}$$

Training dataset consist of 70 sample images of both citrus leave and testing dataset consist of 30 images of disease sample. The classifier trains the diseased leaf on the training set applies it to the testing set and then measure performance by comparing the predicted samples and it gives output as presence of canker disease in citrus plant.

EXPERIMENTAL RESULTS

The performance evaluation of canker detection is implemented using MATLAB under windows environment. This proposed method is evaluated on citrus (lemon) leaves to detect the canker detection. This proposed method adopted by two steps are to enhance the image quality and to detect the canker detection in citrus leaves. In pre-processing step CLAHE is applied to enhance the image quality and SVM classifier is used to detect the canker affected leaves. The various training and testing samples are used and compare with targeted citrus leaf shown in table 1.

Table 1. Training and Testing Set

Classifiers	Training Images	Testing Images
Without CLAHE Enhancement-SVM	70	30
With CLAHE Enhancement-SVM		

Performance Metrics

The proposed methods are evaluated and compared with various classifiers such as K-NN and Navies Bayes in terms of certain performance metrics such as FAR, FRR, GAR, EER and Execution Time.

Equal Error Rate (EER) - It is used to calculate the error rate of performance operating under verification task.

False Rejection Rate and False Acceptance Rate (FRR and FAR) - It is used to measure the process with the system to enroll or getting rejected. FAR defines as the system will incorrectly accept the canker leaves. FRR defines as the system will incorrectly reject the canker leaves,

$$FAR = \frac{wrongly\ accepted\ sample}{Total\ no\ of\ wrong\ match}$$

$$FRR = \frac{wrongly\ rejected\ sample}{Total\ no\ of\ corrected\ match}$$

Genuine Acceptance Rate (GAR) - This is defined as a percentage of genuine canker leaves accepted by the system.

Table 2 shows the comparison of proposed performance is evaluated in terms of without applying CLAHE enhancement and with CLAHE enhancement in pre-processing steps. Then the output of pre-processing is forwarded to other techniques and compared with various classifiers.

Table 2: Performance Comparison of Canker Detection

	Classifiers	FAR (%)	FRR (%)	GAR (%)	EER	Execution Time (ms)
Without CLAHE Enhancement	K-NN	3	2	97	0.72	0.64
	NB	4	4.5	96	0.62	0.57
	SVM	5	6	95	0.54	0.41
With CLAHE Enhancement	K-NN	4.5	4	95.5	0.43	0.33
	NB	5	6	95	0.33	0.25
	SVM	6	8	94	0.24	0.19

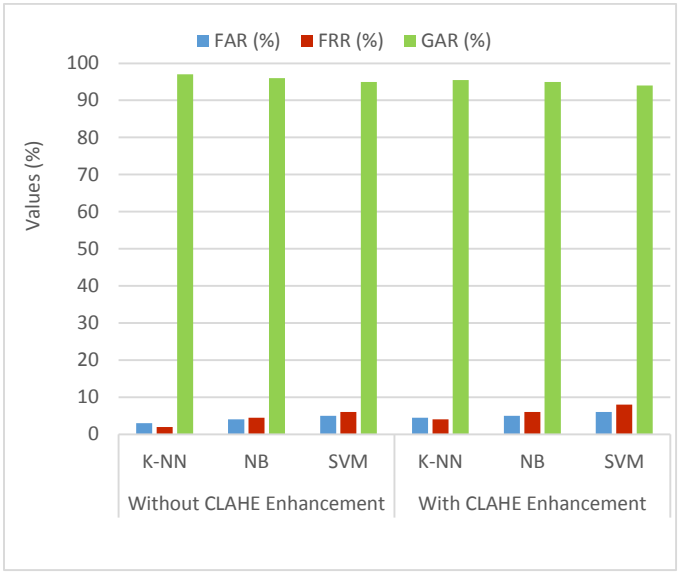

Figure 5 Accuracy Comparison for CLAHE Enhancement

The above figure shows Accuracy prediction of canker detection disease in citrus leaves in terms of FAR, FRR and GAR. It is clearly noted that the pre-processing step with CLAHE Enhancement achieves efficient result integrated with SVM classifiers. The SVM classifiers achieves the good prediction rate for differentiating the canker disease.

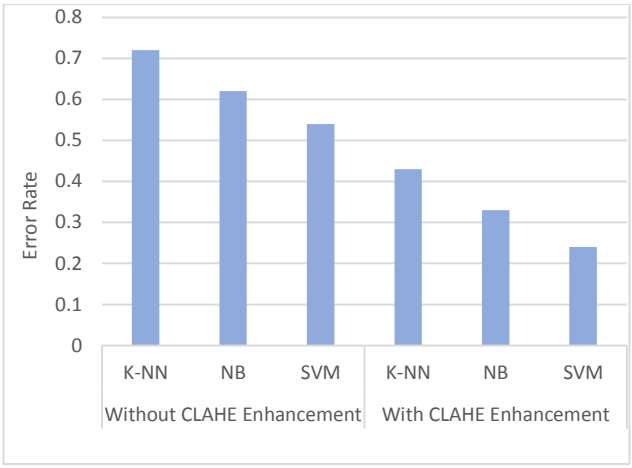

Figure 6 Error Rate Comparison

Figure 6 shows the Error rate comparison of various classifiers in terms of CLAHE Enhancement. The SVM classifiers shows less error rate when compared to other classifiers.

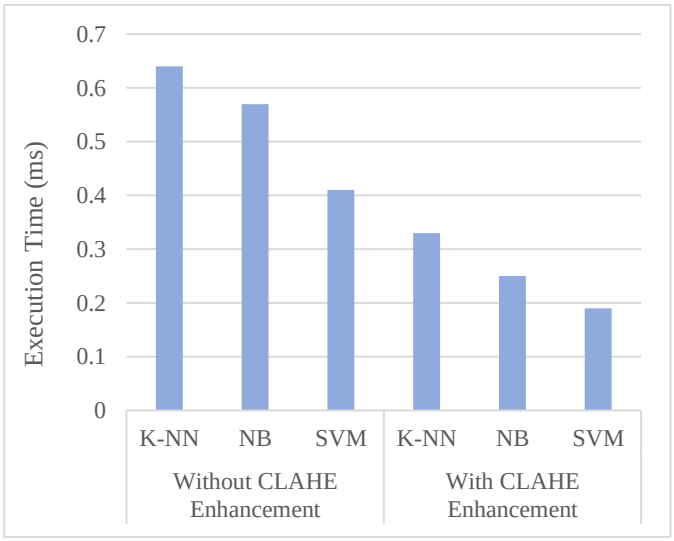

Figure 7 Execution Time Comparison

Figure 7 shows the Execution time comparison of various classifiers in terms of CLAHE Enhancement. The SVM classifiers shows less execution time for detection of canker disease in citrus plant. Less execution and high accuracy will be the effective result for canker prediction.

CONCLUSION

Citrus plant plays an important role in agriculture and medical field. So, this paper represents an approach for canker detection in citrus and enhance the image quality. Digital Image Processing techniques can be employed to detect leaf diseases with accuracy compared to the traditional methods. The paper discussed the CLAHE enhancement method to improve the image quality that can be used to detect Citrus Canker Disease. First the sample leaves images are acquired and segmented into

multiple parts. Then GLCM color and textures features are extracted and SVM classifiers are applied to detect the disease of the leaves. Experimental results demonstrate that our enhancement model outperforms well in terms of image enhancement and the canker detection based classifiers achieves the efficient results of accurately detecting and differentiate the canker leaf disease.

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Explaining user acceptance and usage of social networking sites: the role of trust, social connectedness and visibility in extending UTAUT2

K. Praveena*

SCMS School of Technology & Management,
Prathap Nagar, Muttom,
Cochin, Kerala, India
Email: pravimurali@gmail.com
*Corresponding author

Sam Thomas

School of Management Studies,
Cochin University of Science & Technology,
Ernakulam, Kerala, India
Email: sam@cusat.ac.in

Abstract: Social Networking Sites (SNS) have become ubiquitous and the numerous sites popping up pose challenges to each site in retaining the user base. Different models like TAM, UTAUT, UTAUT2 etc. have explained the acceptance of different technologies and these models are extended using contextual variables with new technologies coming into force. This study aims to explain the acceptance and usage of social networking sites with the help of UTAUT2 by adding three variables: trust, social connectedness and visibility. The result shows that the proposed model explained 66% variation in the usage and 53% variation in explaining the behavioural intention to use social networking sites. Visibility was found to be the main predictor of usage while habit is found to be the main predictor of behavioural intention, followed by social connectedness. The model was found to be a better model than the base model UTAUT2 in explaining the usage of SNS.

Keywords: social networking sites; UTAUT2; nested model; trust; social connectedness; visibility.

Reference to this paper should be made as follows: Praveena, K. and Thomas, S. (2018) 'Explaining user acceptance and usage of social networking sites: the role of trust, social connectedness and visibility in extending UTAUT2', *Int. J. Management Practice*, Vol. 11, No. 3, pp.318–334.

Biographical notes: K. Praveena is a member of the faculty of SCMS School of Technology and Management, Cochin, Kerala, India. She has 11 years of teaching experience and her areas of interest include information systems, research and data analysis.

Sam Thomas is a Professor at the School of Management Studies, Cochin University of Science and Technology (CUSAT), Kerala, India. He is also the Assistant director of Centre of Innovation, Technology Transfer and Industrial Collaboration (CITTIC) at CUSAT. His research and consulting interests

include project management, Entrepreneurship and data analysis. He was also a visiting International Scholar to Western Michigan University, USA and James Cook University, Australia.

1 Introduction

The advancements in the area of information technology have made it ubiquitous and this has made drastic changes in the lives of the people. Most of the information today is processed digitally and communication has been made very simple with the use of technologies. IT has been serving as a catalyst for global integration by creating efficient and effective channels for the exchange of information. The advent of handheld devices has been a boost to the use of different technologies and applications. The desktops and laptops are replaced by mobile devices and thus the flow of information has become smooth. One of the major areas of research in Information Systems is on the acceptance of technology. Researchers have always tried to determine the various antecedents of technology use over the years.

Different theories and models are formulated by the researchers to explain the acceptance of technologies and the usage behaviour. Some of the widely used models explaining the acceptance of technologies are Technology Acceptance Model (TAM), the different extensions of TAM (TAM2, TAM3), Unified Theory of Acceptance and Use of Technology (UTAUT), UTAUT2 etc. These models have identified the different factors that influence the usage intentions and actual usage of a technology/system. With the advent of new technologies and systems, these models are revisited and reframed accordingly to suit the new contexts with the addition of new factors.

Computer mediated communication have paved way for the online social networks. Social Networking Sites have become an integral part of the daily life of common man. The online social networks initially focused on online communities, bringing people together to interact, share personal information and chat rooms. The sites have grown in terms of features and number of users and thus, just from being the use of personal level, it has shifted to organisational use. Several sites were then introduced with varied features and applications to target different strata of people. The use of these sites are now not limited just for communication but expanded to marketing activities, decision making, campaigning, and even e-governance activities. Among the various SNS, Facebook is the largest in terms of number of users and has around 1.59 billion monthly active users by the end of 2015. Facebook is normally termed as an entertainment SNS while there are certain sites which are used solely for professional networking. Among these type of SNS, LinkedIn has the largest user base and are used by professionals for their networking and for other organisational activities like recruitment, online discussions etc.

Though the number of user accounts of the SNS keeps on increasing, many reports suggest that the number of active users in these sites is decreasing. There are a large number of SNS, but people stick on to only certain sites. Further, some SNS like Orkut have been closed by the service providers. There are many indigenous sites popular in their own countries and not offered to others. With many options of SNS available with

varied features, users choose only certain sites and continue using them. Therefore the information on the factors that influence users' continuous intention to use and how to retain users are important for SNS service providers, as well as for those people who use it as a platform for their activities.

The study focuses on developing a model to explain the acceptance and usage of Social Networking Sites (SNS) based on the UTAUT2 model. UTAUT2 has been framed to explain the consumer use of technology and is fit to explain the voluntary use. In the case of SNS, the UTAUT2 factors alone are not sufficient since there are many other psychological factors associated with the use of these sites. SNS is purely a personal choice and different people use these sites for different purposes. Researchers have tried to explain the use of SNS from the angle of personality factors, the psychological factors etc. Since UTAUT2 explains the acceptance and use of technologies, it was chosen as the base model and from extensive literature review, three factors were identified which are suitable to explain the use of SNS as a whole. The three factors chosen are Trust, Social Connectedness and Visibility. SNS is a public platform and as in the case of any online sites, trust is always a main factor determining the usage of the site. Further, the main use of any SNS is to get connected to other people on a virtual platform thus bridging the physical distances and hence social connectedness was chosen as a factor to check for the use of SNS. Most of the people like to be in the public space and post their information; participate in the online forums and discussions so that they are visible in the virtual space. Even introvert persons find SNS as a safe place to express their opinions etc. Hence, visibility was chosen as factor to extend UTAUT2.

The researcher have tried to extend the model by adding three factors- Trust, Social Connectedness and Visibility which are prominent in the case of social media and will improve the explanatory power of the model significantly.

The objectives of the study are

1 to frame a model to explain the acceptance and usage of Social Networking Sites

2 to examine whether a modified UTAUT2 can explain the user acceptance of social networking sites better than the original UTAUT2.

2 Literature review

One of the major areas in the research of Information Systems is on the user acceptance. Several theories and models have been formulated by researchers in the past decades to explain and predict the use behaviour of different technologies/systems. These models have tried to identify the different factors that affect the use behaviour of the systems. These models are revisited and reframed to suit the new contexts due to the introduction of new technologies/systems. Social Networking Sites (SNS) is one integral part of daily life of people in the present scenario. Numerous sites have popped up offering different features and catering to different strata of people. The acceptance and use behaviour of these sites is thus worth investigating with the use of the extant acceptance models. The study focuses to extend the UTAUT2 model to explain the acceptance and usage of SNS by adding three relevant variables from the literature- trust, social connectedness and visibility.

2.1 Social networking sites (SNS)

Social networking websites have been defined as "web based services that allow individuals to (1) construct a public or semi-public profile within a bounded system, (2) articulate a list of other users with whom they share a connection, and (3) view and traverse their list of connections and those made by others within the system" (Boyd and Ellison, 2007). The term "social network" traditionally was used to describe an individual's personal social connections and the social interactions that mostly occur face-to face (Brissette et al., 2000). Several sites have made their place in the e-world with varied features and functions. The motive of use of these sites may be broadly classified into entertainment, professional linking, staying connected and even marketing tool. Around 2.34 billion social networking users are there worldwide (https://www.statista.com/statistics/278414/number-of-worldwide-social-network-users/). In India there are around 200 million active users of Social Networking Sites. The most popular SNS are Facebook, Twitter, LinkedIn, Google+, Instagram etc.

Facebook is the largest in terms of number of users across the world. Facebook launched in 2004 by Mark Zuckerberg, initially was used as an online platform to connect with peers and nears. With the user base expanding, they have different features added to the site and is now used even as a marketing tool by organisations. There are over 1.79 billion monthly active Facebook users worldwide and India holds 195 million users by the end of 2016. Apart from the entertaining purposes, there are certain SNS which focuses on specific purposes. LinkedIn is one such site which is termed as a professional networking site. LinkedIn claims to be the largest in terms of number of users in this segment. There are 467 million LinkedIn users globally and over 30 million users in India.

Though there are a large number of sites with varied and distinct features, the statistics reveal that the number of users remains active throughout only for some sites. The varied features offered by different sites tempt the users to move on to other sites. This shows that there is a necessity to study the factors that influence the usage of Social Networking Sites and these factors might differ with the different nature of the sites.

2.2 Unified theory of acceptance and use of technology

There are different models explaining the acceptance and usage of technologies. Unified Theory of Acceptance and Use of Technology, proposed by Venkatesh et al. (2003) is one popularly used acceptance model. The model has been used by researchers in studying different technologies and found to be a well predictive model. The Unified Theory of Acceptance and Use of Technology (UTAUT) were proposed by integrating eight extant models to predict the user adoption of information technology/systems. The eight models are the theory of reasoned action (TRA), the theory of planned behaviour (TPB), Technology Acceptance Model (TAM), Innovation Diffusion Theory (IDT), the motivational model (MM), a model combining the TAM and TPB (c-TAM/TPB), the model of PC utilisation (MPCU) and social cognitive theory (SCT). The UTAUT holds that four key constructs (Performance expectancy, Effort expectancy, Social influence and Facilitating conditions) are direct determinants of usage intention. UTAUT explained about 70% of the variance in behavioural intention to use a technology and about 50% of the variance in technology use. The different studies on cross cultural validation of UTAUT includes adoption of e-government services in Kuwait (AlAwadhi and Morris,

2008), e-government services in Saudi Arabia (Alshehri et al., 2012), mobile internet usage from China (Zhou, 2011), internet banking in Portugal (Martins et al., 2014), internet banking adoption in Malaysia (Foon and Fah, 2011), ICT adoption (Attuquayefio and Addo, 2014), ERP systems (Fillion et al., 2012), among others. Besides being tested in different cultures, UTAUT has also been tested in different organisational contexts like health care (Kijsanayotin et al., 2009), educational sector (Oye et al., 2011), among others. Venkatesh et al. (2003) has also recognised certain limitations to UTAUT. The measures for UTAUT are to be viewed as preliminary since the core constructs were operationalised using highest loading items from the previous respective scales. The moderating effects are to be further explored.

Later, Venkatesh et al. (2012) proposed UTAUT 2 by integrating additional constructs and relationships to UTAUT. UTAUT 2 was tailored to suit the consumer use context.UTAUT2 was modelled by adding three variables to UTAUT and altering certain relationships in the original model. The three variables that were added to form UTAUT2 are Hedonic Motivation, Price Value and Habit. In UTAUT, age, gender, experience and voluntariness to use were used as moderators while in UTAUT2, voluntariness was removed as a moderator since UTAUT2 is explained in consumer use context. In the past 5 years, UTAUT2 has been researched in the context of different technologies – internet banking (Arenas-Gaitan et al., 2015; Alalwan et al., 2014), online purchasing (Pascual-Miguel et al., 2015), mobile applications (Baptista and Oliveira, 2015) to name a few.

The study has retained the UTAUT2 variables except price value since in the context of SNS, price value is significant with the slashed internet rates and SNS available across different handheld devices. Hence the following hypotheses hold.

Performance Expectancy has a significant effect on behavioural intention to use Social Networking Sites.

Effort Expectancy has a significant effect on behavioural intention to use Social Networking Sites.

Social Influence has a significant effect on behavioural intention to use Social Networking Sites.

Facilitating Condition has a significant effect on behavioural intention to use Social Networking Sites.

Hedonic Motivation has a significant effect on behavioural intention to use Social Networking Sites.

Habit has a significant effect on behavioural intention to use Social Networking Sites.

Facilitating Conditions has a significant effect on Usage of Social Networking Sites.

Habit has a significant effect on Usage of Social Networking Sites.

Behavioural intention has a significant effect on usage of Social Networking Sites.

The proposed model is formed using three variables – trust, social connectedness and visibility to extend UTAUT2.

2.3 Trust

Trust is conceptualised as a belief that the other party will behave in a dependable, ethical and socially appropriate manner (Kumar et al., 1995; Hosmer, 1995; Zucker, 1986) Trust is a strong determinant in the concept of user acceptance of technology. With new online technologies dominating the market, the role of trust stands significant. People use SNS to share their photos and personal details and hence trust on these sites has been studied by researchers. According to Kim and Ahmad (2013), trust has a key role in social media – sharing communities, since content sharing and dissemination occurs in these social interactions. Hence the following hypothesis is formulated.

Trust has a significant effect on behavioural intention to use Social Networking Sites.

Trust has a significant effect on Usage of Social Networking Sites.

2.4 Social connectedness

Social connectedness refers to a person's subjective awareness of being in close relationship with the social world *in toto* (Lee and Robbins, 1995). The main use of SNS is to maintain relationships and connectedness online. Prior researches have shown that socialising is one of the main reasons why people use SNS such as Facebook (Liu, 2008; Boyd and Ellison, 2007). Kwon et al. (2014) states that perceived connectedness has a major role in determining user attitudes towards Facebook. By status updates, posting photographs and videos, exchanging life events, involving in discussions etc., SNS allow users to maintain, continue and strengthen their relationships (Cornejo et al., 2013). Since Social Connectedness is a significant factor in predicting the use of SNS, the following hypotheses is formulated.

Social Connectedness has a significant effect on behavioural intention to use Social Networking Sites.

Social Connectedness has a significant effect on Usage of Social Networking Sites.

2.5 Visibility

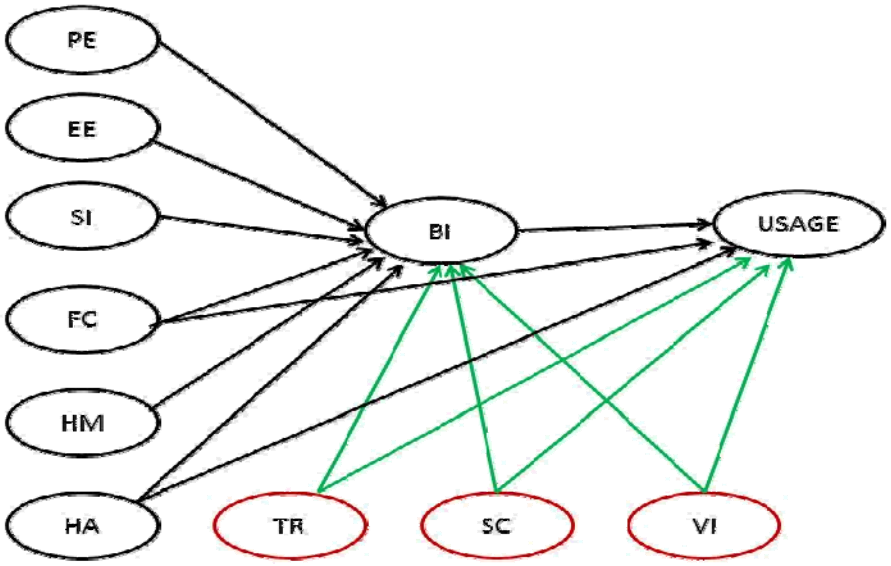
Visibility, a personality based dimension is represented by the derived significance among others on account of an actor's ability to cope with uncertainty and perform non-routine and critical activities. According to Bregman and Haythornthwaite (2003), visibility refers to "mean, methods and opportunities for presentation" Self presentation is one of the major motivation of using social networking sites (Seidman, 2013). Users use SNS as a media to create impressions and image of the self. Visibility is one of the significant factors in the usage of SNS and hence the hypotheses are stated as follows:

Visibility has a significant effect on Usage of Social Networking Sites.

Visibility has a significant effect on behavioural intention to use Social Networking Sites.

The conceptual model is depicted in Figure 1.

Figure 1 Conceptual model



Notes: PE: Performance Expectancy, EE: Effort expectancy, SI: Social Influence, FC: Facilitating Conditions, HM: Hedonic Motivation, Ha: Habit, TR: Trust, SC: Social Connectedness, VI: Visibility, BI: Behavioural Intention)

3 Research methodology

A questionnaire survey was undertaken to meet the aim of the research. The study has chosen two representative SNS – Facebook and LinkedIn, based on the difference in nature of the uses of these sites and both being the top in terms of number of users in their respective categories. The population is defined as the non-commercial users of SNS who are above the age of 18 years. The sampling method used was quota sampling to choose the quota to suit the age and gender wise distribution as per the national statistics. The analysis is done using Structural Equation Modelling (SEM) and hence the sample size estimation considered the requirements of SEM. The quota was fixed at 1200 for Facebook and 300 for LinkedIn.

3.1 Measurement

The questionnaire had two parts: Part A captured the demographic profile while Part B was designed with questions to measure the constructs of the study. UTAUT2 constructs – Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions, Hedonic Motivation, Habit & Behavioural Intention were adapted from Venkatesh et al. (2012). Trust was measured using items adapted from Gefen et al. (2003) and Koufaris and Hampton-Sosa (2004). Social Connectedness was measured using items adapted from Lee and Robbins (1995) and Visibility was measured by items adapted from Reddy and Williams (1988). Usage was measured by variety and frequency of use. The time spent actively on these sites was also considered as a measure of the usage.

3.2 Analysis

998 usable questionnaires were used for analysis. The descriptive statistics of the sample are as follows.

3.2.1 Classification based on gender

The distribution of the sample over the age shows that the highest number of users is in the age group of 18–25 for Facebook and in 26–34 for LinkedIn.

The data collected is in tune with the available statistics and the quota chosen represents the population in case of both gender and age.

Table 1 Gender statistics of the sample

		Gender		*Total*
		Male	*Female*	
Facebook	Frequency	360	384	744
	Percent	48.4	51.6	100
LinkedIn	Frequency	186	68	254
	Percent	73.2	26.8	100
Total	Frequency	546	452	998
	Percent	54.7	45.3	100

Structural Equation Modelling (SEM) was used to test the model. SEM is a multivariate statistical methodology, which takes a confirmatory approach to the analysis of a structural theory. SEM provides researchers with the ability to accommodate multiple interrelated dependence relationships in a single model. SEM was done using AMOS 21. The reliability of the scale was ensured at the first level. Next, Confirmatory Factor Analysis (CFA) is done to confirm the factor structure and the validity is tested further. This is followed by the assessment of the structural model.

The reliability of the scale was done by the method of internal consistency measurement using Cronbach's alpha and is given in Table 2.

Table 2 Cronbach's alpha values to measure reliability

Variable	*Cronbach's alpha*
Performance Expectancy	0.946
Effort Expectancy	0.916
Social Influence	0.940
Facilitating Conditions	0.876
Hedonic Motivation	0.950
Habit	0.961
Trust	0.935
Social Connectedness	0.956
Visibility	0.898
Behavioural Intention	0.939
Usage	0.901

It is seen that all the values are above the cut of 0.7 as suggested by Nunnally (1978) and hence the reliability is established.

Confirmatory Factor Analysis (CFA) focuses on the extent to which the observed variables are generated by the underlying factors. The measurement model includes the items measuring the constructs in the conceptual model. The values of fit measures obtained from CFA for the conceptual model are as follows: Chi-squared with 934 degrees of freedom =1923.522, $p<0.01$; the ratio of chi square to number of degrees of freedom (normed χ^2) = 2.059. The fit indices are given in Table 3.

Table 3 Fit indices of the measurement model

FIT indices	*Values*
Comparative Fit Index (CFI)	0.975
Goodness of Fit Index (GFI)	0.920
Adjusted Goodness of Fit Index (AGFI)	0.908
Normed Fit Index (NFI)	0.953
Relative Fit Index (RFI)	0.948
Standardised Root Mean Squared Residual (SRMR)	0.0329
Root Mean Square Error of Approximation (RMSEA)	0.033

The values of the fit indices shows good fit as the values are close to 1 and hence the measurement model can be considered as a good fit model. The results show that Hoelter's 0.05 and 0.01 critical *N* values are 522 and 538. Hence the sample size is shown as satisfactory for running the model. The validity of the scale is established with the help of the CFA.

Validity is defined as the extent to which any measuring instrument measures what it is intended to measure. The questionnaire was scrutinised by academicians and experts in the field and certain items were reworded and hence the face validity was ensured. The Average Variance Extracted (AVE) values are found to be greater than 0.5 and the standardised factor loadings corresponding to each item of the latent constructs in the model are greater than 0.7, thus ensuring convergent validity. The square root of every AVE value belonging to each latent construct is found to be much larger than any correlation among any pair of latent constructs and hence discriminant validity is ensured. Thus the construct validity is established.

It is seen that the measurement model falls in the good fit standard as all the fit indices are above 0.90. Hence, the present measurement model can be accepted. The further testing of the structural model can thus be initiated fixing the measurement model as above.

The following steps are done to assess the structural model.

First the conceptual model is tested with the integrated data of both Facebook and LinkedIn for the fit. Secondly, the conceptual model is tested with the original UTAUT model. This is done to check if the conceptual model explains USAGE better than the original model with the data set.

The model is tested with SEM using AMOS 21.0. The chi-square value = 1912.888 with 937 degrees of freedom and is found to be significant ($p<0.05$). The fit indices are displayed in Table 4.

Table 4 Fit indices of the structural model

Indicators	*Values*
Normed Chi-square	2.042
GFI	0.920
AGFI	0.908
SRMR	0.033
NFI	0.953
RFI	0.948
IFI	0.975
TLI	0.973
CFI	0.975
RMSEA	0.032

From the table, it is evident that the conceptual model fits well, as all the fit indices shows a good fit.

Next the model is tested for the parsimony and the values are reported in Table 5.

Table 5 Comparison indices

Model	*AIC*	*BCC*	*BIC*	*CAIC*
Hypothesised model	2202.888	2217.235	2914.222	3059.222
Saturated model	2162.000	2268.962	7465.119	8546.119
Independence model	40797.329	40801.881	41022.994	41068.994

It is seen that the BCC, BIC and CAIC values are lower than the Saturated model and the Independence Model, while the AIC value is closer to the saturated model than the to the independence model. This shows, by comparative fit measures the hypothesised conceptual model is better than both the saturated and the independence model.

The conceptual model shows a good fit and hence can be accepted. Next the paths are checked for the significance to check if our stated hypotheses hold or not.

The hypotheses tested are as in Table 6.

The analysis of hypotheses shows that Performance Expectancy (PE), Effort expectancy (EE), Habit (HA), Trust (TR), Social Connectedness (SC) and Visibility has a positive significant effect on Behavioural Intention (BI) to continue the use of Social Networking Sites (SNS). Social Influence (SI), Facilitating Conditions (FC) and Hedonic Motivation (HM) are found to be not significant in predicting BI. In the case of USAGE, Habit (HA), Social Connectedness (SC), Visibility (VI) and BI were found to be significant predictors while, Facilitating Conditions (FC) and Trust (TR) were found to be not significant. It is seen that Habit (HAB) is the main predictor of Behavioural Intention (BI), followed by Social Connectedness (SC). Visibility is the main predictor of USAGE, followed by Behavioural Intention. The model is found to explain 53% variation in explaining Behavioural Intention and 66% in explaining USAGE. Hence it can be concluded that the conceptual model can be taken as a good model to explain the usage of social networking sites.

Table 6 Hypothesis testing

H1	PE has a significant effect on BI	Accepted
H2	EE has a significant effect on BI	Accepted
H3	*SI has a significant effect on BI*	*Rejected*
H4	*FC has a significant effect on BI*	*Rejected*
H5	*HM has a significant effect on BI*	*Rejected*
H6	HA has a significant effect on BI	Accepted
H7	TR has a significant effect on BI	Accepted
H8	SC has a significant effect on BI	Accepted
H9	VI has a significant effect on BI	Accepted
H10	*FC has a significant effect on USAGE*	*Rejected*
H11	HA has a significant effect on USAGE	Accepted
H12	SC has a significant effect on USAGE	Accepted
H13	VI has a significant effect on USAGE	Accepted
H14	*TR has a significant effect on USAGE*	*Rejected*
H15	BI has a significant effect on USAGE	Accepted

3.3 Comparing the conceptual model and the original UTAUT2 model

The conceptual model framed above is found to explain the usage of social networking sites and has a good explanatory power. To check whether the conceptual model explains the usage better than the original UTAUT2 model, the proposed conceptual model is tested with the original UTAUT 2 model on the same data set. The nested model comparison is used for this purpose.

"A model M_2 is said to be nested in another model M_1 if the set of freely estimated parameters in M_2 is a subset of those in M1 and is denoted as $M_2<M_1$" (Anderson and Gerbing, 1998). The UTAUT 2 model and the conceptual model proposed here can be called as nested since they are hierarchical models based on the same data set (Ho, 2006). The UTAUT 2 model is represented in Figure 2. It can be noted that UTAUT2 is a subset of the conceptual model.

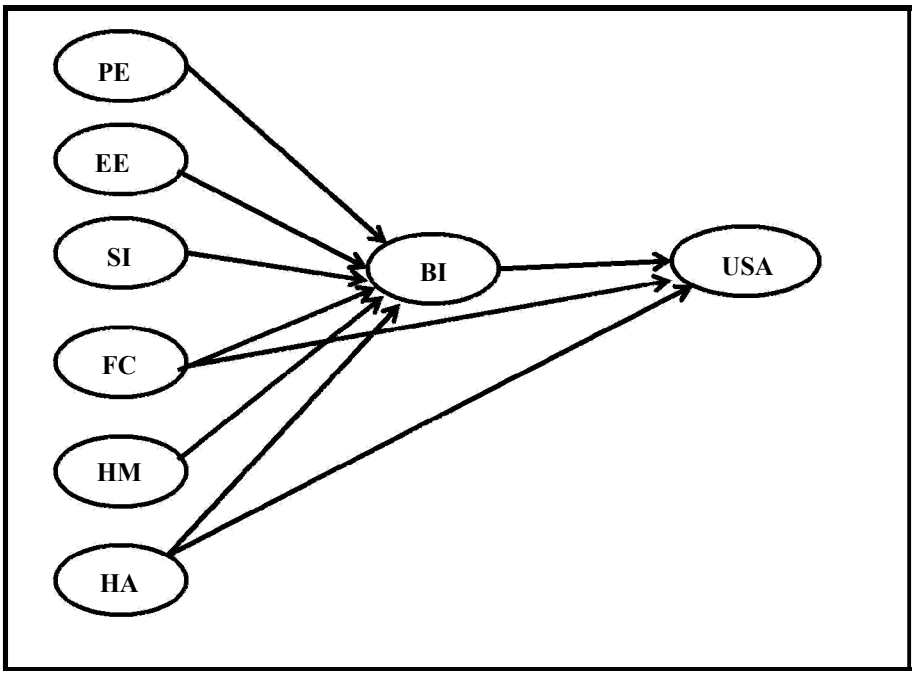
Since these nested models possess different degrees of freedom, their goodness of fit can be directly compared via multimodel analysis. The following steps are done for this process.

1 Defining the full Unconstrained model (with all the paths i.e., the conceptual model).

2 Defining the Constrained model in which the 5 paths (Trust → Behavioural Intention, Social Connectedness → Behavioural Intention, Visibility → Behavioural Intention, Social Connectedness → Usage, Visibility → Usage) are constrained to zero. When the paths are constrained to zero, it is equivalent to those paths not being estimated.

Here, the unconstrained model is the proposed conceptual model and the constrained model is the original UTAUT2 model. The model is tested using AMOS.

Figure 2 UTAUT2



The results on testing both the models are as in Table 7.

Table 7 Model results

Model	*NPAR*	*CMIN*	*DF*	*P*	*CMIN/DF*
Unconstrained model	144	1912.888	937	0.000	2.042
Constrained model	139	2178.920	942	0.000	2.313
Saturated model	1081	0.000	0		
Independence model	46	40705.329	1035	0.000	39.329
Baseline Comparisons					
	NFI	*RFI*	*IFI*	*TLI*	
Model	Delta1	rho1	Delta2	rho2	CFI
Unconstrained model	0.953	0.948	0.975	0.973	0.975
Constrained model	0.946	0.941	0.969	0.966	0.969
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000
Assuming model Unconstrained model to be correct:					
Model	*DF*	*CMIN*	*P*	*NFI*	*IFI*	*RFI*	*TLI*
				Delta-1	Delta-2	Rho-1	RHO-2
Constrained model	5	266.032	.000	.007	.007	.007	.007

It can be seen from the above tables that both the unconstrained model (conceptual model) and the constrained model (the UTAUT2 model) have good fit. The next step is to check which model fits better since both these models is found to have a good fit (fit indices>0.90). The goodness of fit can be directly compared since both these models are nested and have different degrees of freedom. The chi square difference between the constrained and unconstrained model is 266.032 (2178.920 – 1912.888). With 5 degrees of freedom (942 – 937), this statistic is significant at the 0.05 level. Hence, though both the models fit well, the Conceptual model represents a significantly better fit and can be chosen as a better model over the original model.

Also form Table 7, it can be seen that the unconstrained model i.e., the conceptual model has better fit indices than the constrained model (the UTAUT2 model).

Further, we use the comparison indices (AIC, BCC and BIC measures) to check for the comparison of the models for parsimony.

From Table 8, looking at the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC), the unconstrained model (the conceptual model) yielded lower values. This indicates that the conceptual model is both better fitting and more parsimonious than the UTAUT2 model. Considering all the fit indices, the chi square difference statistic and the comparison fit indices it can be seen that the conceptual model is a better fit model than the UTAUT2 model for the data set.

Table 8 Comparison indices

Model	*AIC*	*BCC*	*BIC*	*CAIC*
Unconstrained Model	2200.888	2215.137	2907.317	3051.317
Constrained Model	2456.920	2470.674	3138.820	3277.820

For the conceptual model the squared multiple correlation value for Behavioural Intention is 0.527 and for USAGE is 0.661 while for the UTAUT2 model, the squared multiple correlation value for Behavioural Intention is 0.468 and for USAGE is 0.618.ie, the conceptual model explains 52.7% variation in predicting Behavioural Intention while for UTAUT2 model, it explains only 46.8% variation. The conceptual model explains 66.1% variation in predicting USAGE while UTAUT2 explains only 61.8% variation. The proposed conceptual model hence explains more variation than the original UTAUT2 model in this case.

Thus it can be concluded that the proposed model is both a better and parsimonious model than the original UTAUT2 in explaining Behavioural Intention to continue and usage of Social Networking Sites.

4 Discussion

The present research aims to frame an extended model to explain the intention to continue and use social networking sites. First, a model was proposed by extending the UTAUT2 model with three added variables: Trust, Social Connectedness and Visibility. This model was tested using structural equation modelling. Second, the model was compared and tested with the base model UTAUT2 with the same data set. Since UTAUT2 was developed to explain the consumer use context, the model was chosen as

the base model for this study. The researcher has tried to extend UTAUT2 with three variables – Trust, Social Connectedness and Visibility. These three variables were chosen from literature since they are found to be significant factors in the context of use of SNS. It was found that the proposed conceptual model can be accepted with a good fit and it explained 66% variation in the usage and 53% variation in explaining the behavioural intention to use social networking sites.

The study has shown that Trust is a significant predictor of Behavioural Intention to use SNS. This is in line with the studies of Information System researchers who have found trust to be a determinant of the use of different systems and technologies. Trust is a strong factor governing the use of information systems, especially online technologies. The study results are in tune with the prior studies of Lankton and McKnight (2011), Gefen et al. (2003), wherein trust is a major predictor of behavioural intention in the case of online systems.

Social Connectedness is found to be a good predictor of Behavioural Intention in this study. The use of social networking sites normally revolves around the concept of remaining connected with others. Köbler et al. (2010) have stated that people create profiles and update their status to increase their feel of being connected. The study has reasserted the fact that people want to remain connected and one of the main reason they use these social networking sites is for connectedness.

The study results show that the added variable- Visibility also has a significant influence on the Behavioural Intention as well as Usage of Social Networking Sites (SNS). Visibility is found to be the main predictor of Usage in the study. People update their profiles, post photos and opinions so that they get noticed by others in the network. Online visibility has also been researched to measure the organisations' visibility (Drèze and Zufryden, 2004). The study supports the prior researches where researchers have pointed out the use of SNS for self-presentation (Herring and Kapidzic, 2015; Schwämmlein and Wodzicki, 2012).

Further from the UTAUT2 variables, it is found that Performance Expectancy, Effort Expectancy and Habit were found to have a significant influence on Behavioural Intention. The usefulness, easiness in use and the regular habit of using these sites drives the intention to use SNS. It was found that Social Influence, Hedonic Motivation and Facilitating Conditions were found to be insignificant in determining Behavioural Intention. Since majority of the people these days are heavy users of SNS and the sites offered in all hand held sites, Social Influence and Facilitating Conditions are termed out to be insignificant.

The area of information systems research has always focused on extending the models of technology acceptance by adding variables and increasing the predictive power of the models. The use of social networking sites is voluntary and the UTAUT2 constructs alone are not sufficient to explain the usage. Hence the addition of psychological variables is significant in studying the user acceptance of social networking sites. Moore and McElroy (2012) have stated that personality influences the use of Facebook and adds that incorporating personality into existing models of technology adoption and use (TAM, UTAUT) will explain the use of these sites. The proposed conceptual model was then tested with the original UTAUT2 model to ensure if it explains the variation better than the original model. The test was done using the chi square difference test and the nested model comparison was done to compare the models.

The comparison indices and the squared multiple correlation values also shows that the proposed model explains the usage better than the original model with the same data set. Both the Behavioural Intention and Usage is found to be better explained by the proposed model when compared to the UTAUT2 model.

5 Implications

The work contributes to the stream of literature on the formation of an extended model in explaining the use of Social Networking Sites. The major theoretical contribution is in modifying UTAUT2 for the use context of social networking sites by adding three factors to the model-Trust, Social Connectedness and Visibility. The addition of psychological and personality variables to the extant model makes the model have more explanatory power. Hence the model proposed is an addition to the existing models of technology acceptance and use. The study contributes to the literature of SNS by identifying the factors that predict the intention to continue the use of sites as well as the usage of these sites. From a practical perspective, insights provided by the study can help SNS developers understand user motivation and thus design more effective marketing strategies. The SNS can use the understanding of these factors to enhance user's acceptance and make them continue the use of these sites. The purposes of different SNS are varied and hence each SNS can focus on the factors of user acceptance accordingly.

6 Limitations

There are many new applications under the broad category of social media and the study has focused only on the social networking sites available across different platforms. Only two Social Networking Sites are considered for the study based on the classification of the purposes of these sites. Hence the generalisability may be limited to such types of sites alone since different sites have different features (hedonic and professional sites) and hence the factors studied may not be enough to explain the usage. The study has not considered the difference in platforms offering the access to these sites. The study has focused on the voluntary users of Social Networking Sites and those users who use them for commercial and organisational purposes are not included.

7 Scope for future research

The study has focused on Social Networking Sites (SNS) and future studies can be directed to test the model across the broad offerings of Social Media. Future research can focus on adding more contextual variables like perceived risk, sense of belongingness, reciprocity etc. and also personality dimensions like extraversion, neuroticism, the big five personality traits etc. to make the model more robust. Research can also be conducted on the offering of SNS on different platforms since the advent of smart phones and tablets have made the SNS available on mobile platforms and the users have switched on to the use of these sites on these platforms in recent times.

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Integrated technology for producing eco-friendly coconut biofuel through cost effective way.

Author(s) : Mohankumar, C. ; Salini Bhasker ; Harish, M.
Author Affiliation : Bio-Science Division, SCMS Institute of Bioscience and Biotechnology Research & Development, South Kalamassery, Cochin - 682 033, Kerala, India.
Author Email : mohankumar@scmsgroup.org
Journal article : Indian Coconut Journal 2018 Vol.61 No.7 pp.12-14

Abstract : This paper provides information on the benefits of an integrated approach of producing coconut biofuel from dehusked mature nuts by utilizing the subproducts derived at each level of processing (coconut shell, coconut water, oil cake and glycerol) in helping coconut farmers by providing a stable market price for their products. The ecologically friendly nature of coconut biofuel is also discussed.

ISSN : 0970-0579
URL : http://www.coconutboard.nic.in
Record Number : 20193015983
Publisher : Coconut Development Board
Location of publication : Kochi
Country of publication : India
Language of text : English

Indexing terms for this abstract:

Organism descriptor(s) : Cocos nucifera

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Author Affiliation : Bio-Science Division, SCMS Institute of Bioscience and Biotechnology Research & Development, South Kalamassery, Cochin - 682 033, Kerala, India.
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beverages

MDPI

Article

Coconut Neera—A Vital Health Beverage from Coconut Palms: Harvesting, Processing and Quality Analysis

Mohankumar Chinnamma *, Salini Bhasker, Malavika Binitha Hari, Divyaa Sreekumar and Harish Madhav

Molecular Biology Division, SCMS Institute of Bioscience and Biotechnology Research and Development (SIBBR&D), Management House, South Kalamassery, Cochin 682033, Kerala, India; salini.bhasker@scmsgroup.org (S.B.); malavikabh@gmail.com (M.B.H.); divyaa.sreekumar5@gmail.com (D.S.); harish@scmsgroup.org (H.M.)
* Correspondence: directorsibb@scmsgroup.org; Tel.: +91-484-255-6315

Received: 12 January 2019; Accepted: 30 January 2019; Published: 2 March 2019

Abstract: Nature has made nutritive products in such a way that it cannot be manufactured in laboratories or in mills. Coconut Neera is the natural sap of the mature coconut palms rich with all essential nutrients, minerals and vitamins for human health. Harvesting of Neera from the spadix of the palms without disturbing the physiology of the tree has a lot of potential at the industrial scale. However, the development of alcohol in the extracted sap during tapping by auto-fermentation has given a misnomer for Neera as "sweet toddy". Hence, the commercial popularity of Neera as a health drink has diminished at a global level. Though several traditional techniques like the usage of calcium hydroxide (lime) and the application of the chiller device during harvesting Neera from spadix have been practiced for collecting non-fermented Neera, none of the techniques were found acceptable at the commercial level. The results of the present study demonstrate the harvesting and processing procedure standardized for the collection and storage of non-fermented Neera from palms by repeated field trials. The cumulative effect of the anti-fermentation solution (AFS) with the presence of the two preservatives—citric acid (5 mM) and potassium metabisulphite (2 mM)—by preventing fermentation from the level of harvesting to processing was confirmed. The zero content of alcohol in raw Neera indicates the AFS action. The proximate composition of primary constituents and the content of minerals, amino acids and vitamins present in Neera highlights its nutrient value as a health beverage. The higher content of minerals—sodium and potassium (15.2 mg and 100 mg), the elevated level of amino acids-cysteine (14 mg), tyrosine (7.11 mg), arginine (7 mg) and the presence of vitamin C (65 mg) and vitamin A as retinol (4.88 IU)—indicates the therapeutic importance of coconut Neera. The data of oral toxicity and the glycemic index further support the vital quality.

Keywords: *Cocos nucifera*; coconut palms; coconut Neera; anti-fermentation solution; harvesting and processing; Neera sugar; Neera concentrate

1. Introduction

Coconut has been in existence for millions of years in almost all tropical countries, and the people of the tropical world use a eulogistic epithet "Tree of Life" for coconut palms. This is because whatever is needed for one's livelihood—food, fuel, medicine and shelter—is available from this wonder palm. Coconut palm has been studied mostly from the commercial angle, as it is the source of edible oil, food, coconut water, coconut milk, fibre, wood and fuel. Because of the diversified food value, the potential of coconut can be exploited from the flowering phase to the mature nut [1]. At the reproductive phase, a coconut tree develops bunches of male and female flowers that are kept inside in a protective coat

safely, called spadix, until it blossoms for reproduction (Figure 1). The sweet sap of unblossomed mature spadix of coconut trees has been used as a natural drink for decades, but its marketing stability at the commercial scale is not at all competent due to the fermented nature of the drink, leading to the formation of alcohol. Technically, the sweet sap oozed out during tapping from the spadix has two nutritional status: (i) Fermented sap with 5–8% alcohol called sweet toddy and (ii) non-fermented sap named Neera with zero alcohol. Though both the saps have vital nutrients, the presence of alcohol in sweet toddy remains as a hurdle for popularizing it as a natural soft drink. The major concern of the Neera industry is to maintain the nutritional quality with zero alcohol since Neera has an innate tendency of auto-fermentation. Hence, the harvesting of Neera without auto-fermentation remains as a challenge before the Neera industry. Despite the traditional approach of tapping, a scientific approach for harvesting and processing Neera by maintaining its nutritional and therapeutic value at the industrial scale has not been done properly.

Figure 1. The unblossomed spadix of a mature coconut palm.

Generally, the tapping procedure followed for Neera production is precisely a repetition of the traditional toddy extraction, and this may be the possible reason that Neera has got the misnomer "sweet toddy" [2,3]. Therefore, the major threat in the harvesting process of Neera from the spadix of coconut palm is the natural fermentation or auto fermentation of the sap. Being a natural sugary solution extracted from the plant tissue, it has an innate tendency of getting fermented and it can happen by two means: auto-fermentation of the sap and unhygienic harvesting and storage. Fresh coconut sap (Neera) at the time of harvest is sweet in taste with all the vital nutrients of an energy health drink. However, the innate association of micro-organisms like yeast and bacteria in the sweet sap activates fermentation, resulting in the production of ethyl alcohol [4]. Therefore, the present investigation was undertaken with the aim to produce non-fermented Neera from coconut palms with the following objectives: to develop an exclusive harvesting procedure for Neera by preventing the in situ fermentation at the field itself, to design a processing protocol for the harvested Neera with a stable shelf life at room temperature and to analyze the nutritional quality of the processed Neera for determining its vital nature as a health beverage.

2. Materials and Methods

The methodology part of the investigation was carried out under four phases: tapping and harvesting; processing and storing the harvested Neera; conducting a nutritional analysis; preparing the value-added products from Neera.

2.1. Tapping and Harvesting

A scientific approach was maintained for the harvesting by following modifications in the traditional tapping practiced by the toddy tappers (Figure 2): (i) The selection of healthy palms: As the first step of tapping, 250 healthy coconut palms (*Cocos nucifera*) of approximate 25–30 m with mature unblossomed spadix were selected for the study. The height of the tree, number of mature spadix and general health of the palms were taken as the criteria for selection. (ii) Surface sterilization of the palm crown: For the tapping process, traditional toddy tappers were identified and trained. Unlike the traditional tapping for getting toddy from palms, the crowns of the palms were cleaned properly by the tapper to expose the spadix for the smooth tapping. As the first step of Neera harvest, a mild disinfectant—0.05% sodium hypochlorite—was sprayed in the crown to create an aseptic environment. (iii) Cleaning of the spadix: The identified spadix for tapping was sprayed with distilled water from the base to the top for cleaning. After washing, the surface of spadix was cleaned by tissue paper to make it dry. (iv) Beating of the spadix: The cleaned spadix was subjected to an initial beating process from the base to the top with a professional skill for 3–4 days. After the initial beating, the tip of the spadix was chopped with a sharp sterile knife—the indigenous tool of the traditional tapper. The beating process was continued for 10–15 days. Every day, the chopped end of the spadix was covered by a sterilized plastic mesh carefully after the beating. This was for preventing entry of insects and other small organisms. The beating was done twice—in morning and evening. (v) Application of the sterilized clay on the spadix: The excised end of the spadix always appeared as wet due to the exudation of Neera from the spadix during the beating process. There is every possibility of leaching of this sugary exudate to the basal part of the spadix which will damage the entire system. This can be prevented by spreading a sticky matrix on the surface of the cut end. Traditionally toddy tappers were using sticky natural clay on the surface. In the case of Neera harvesting, slight modification was made by sterilizing the clay, i.e., sterilized clay was applied on the cut end of the spadix by the tapper. The tapper should wear gloves while applying the clay so that further contamination can be avoided. The clay was sterilized by autoclaving. (vi) The collection vessel: Traditionally a clay pot was used for the collection by toddy tappers. Due to the repeated use of the pot by the tappers, for the collection, it was not properly maintained in a hygienic way. In the case of Neera harvesting, an aseptic mode was created by using a sterilized plastic vessel of 5 L capacity. The vessel was cleaned and sterilized prior to the insertion to the processed spadix for collecting Neera. (vii) Insertion of the sterile vessel: The vessel was inserted to the spadix after 15–20 days of beating based on the flow of Neera from the spadix. After 15–20 days, Neera was exudated from the processed spadix at a rate of 100–200 mL initially and the volume was increased to 1 L after one month and subsequently to 2 L after two months. The volume of the Neera exudate varied from palm to palm based on several factors—age, height, health of the palm and time of collection. (viii) Collection of the Neera: The vessel can be kept for collection at two times—once in the morning and the other in the evening in the same spadix. The collection vessel kept in the morning can be harvested in the evening, and the vessel kept in the evening can be harvested by the next day's morning. Therefore, an average yield of 2 L/palm/day can be harvested, but depending on the age and health of the palms, the volume will increase to 3–5 L/palm/day. The Brix value of the harvested Neera was checked by using a refractometer at the plantation.

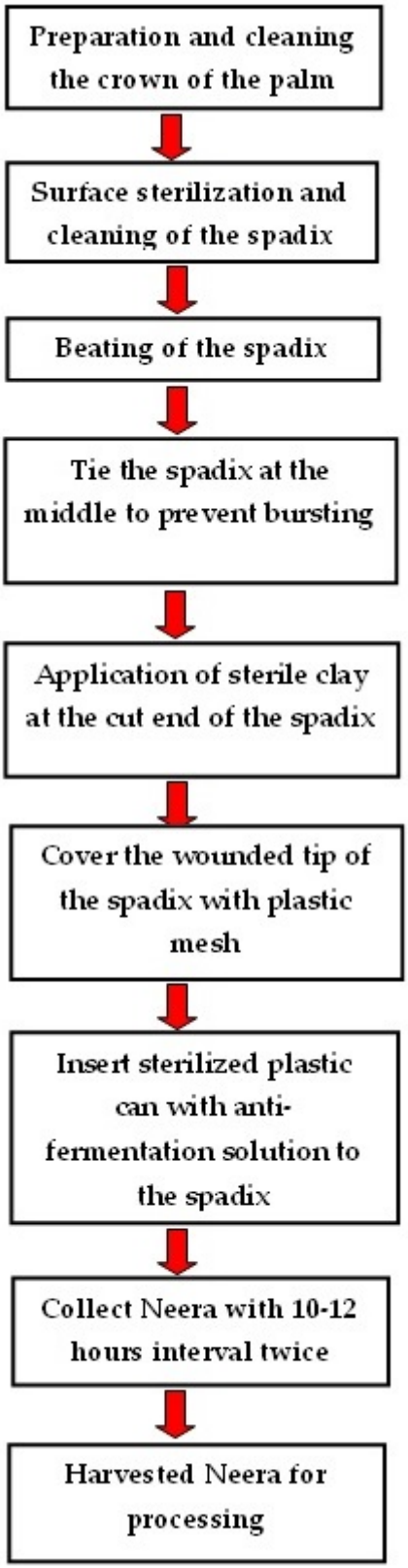

Figure 2. The modified harvesting steps of coconut Neera.

2.2. Preparation and Usage of the Anti-Fermentation Solution (AFS)

A new combination was prepared for suppressing the tendency of fermentation of raw Neera during harvesting with respect to its mode of action. Proper standardization was done by several

repeated field trials for optimizing the anti-fermentation formula. Raw Neera exudated from the coconut spadix during harvesting has got the innate tendency of getting fermented. Therefore, it is essential to prevent the auto-fermentation by suppressing the growth of microbes prior to processing. An anti-fermentation solution (AFS) was prepared by the combination of two chemicals—citric acid (CA) and potassium metabisulphite (KMS)—that have been accepted as preservatives in food and natural drinks [5]. The combination of the two salts was optimized to the level of 4–5 mM for citric acid with a concentration of KMS 1.5–2.5 mM in raw Neera/L. Using the treatment of the anti-fermentation solution in the harvested Neera, yet another problem appeared that was the fermentation of raw Neera at the crown within the collection vessel during harvesting. Though traditionally the toddy tappers have been practicing the usage of calcium hydroxide (lime) in the collection vessel for collecting sweet toddy, the presence of lime remains as a health hazard. Moreover, the processing steps of removal of the lime look more tedious. Therefore, the fermentation of Neera within the collection vessel was checked by adding a concentrated volume of 10 mL AFS/L Neera with the same molarity (5 mM CA and 2 mM KMS) to the collection vessel at the time of insertion by the tapper. Based on the volume of Neera exudate from each palm, the volume of AFS can be adjusted by the tapper.

2.3. Processing and Storage of Harvested Neera

The harvested Neera was filtered at the plantation itself through a cheese cloth for removing the solid debris. The filtered Neera was stored in a can and transported to the laboratory for further processing. Prior to the processing of the raw Neera, the brix value and the pH of the harvested Neera were checked. The processing steps include (i) Microfiltration, (ii) Pasteurization, (iii) Bottling and (iv) Storage (Figure 3).

(i) Microfiltration: The raw Neera was filtered through micro filters with a pore size of 100 microns under aseptic conditions.
(ii) Pasteurization: The filtered raw Neera was stored in a sterilized vessel for pasteurization for 10–15 min at a temperature range of 75–85 °C. A mild agitation was inevitable during pasteurization. The temperature was kept constant at 80 °C during pasteurization by remote control.
(iii) Bottling: The pasteurized Neera was bottled by an automatic bottling machine with a volume (200 mL) in polypropylene (PP) bottles and 300 mL in glass bottles and capped and sealed automatically. The entire steps were done in a closed system for avoiding further contamination during processing.
(iv) Storage: Shelf life was checked periodically by analyzing the pH, brix value and nutritional components.

2.4. Quality Analysis of Neera

As the first part of the analysis, the Neera was subjected to the quantification of the microbial load at three levels: (a) Raw Neera at the time of harvest, (b) processed Neera and (c) processed Neera after 3 months of storage. The total fungal count was estimated by following the protocol of the Indian Standard: 5403 test method [6]. A yeast extract-dextrose-chloramphenicol-agar medium was prepared, and pour plates were made using the raw, processed and stored Neera samples at different dilutions. The plates were then incubated at 25 ± 1 °C for 3 days. A control plate was also maintained. The total bacterial count was detected following the IS: 5402 test method. The yeast extract-glucose-casein agar medium pour plates were prepared using the raw, processed and stored Neera samples at different dilutions. They were incubated at 30 ± 1 °C for 72 h. A control plate was also maintained [7].

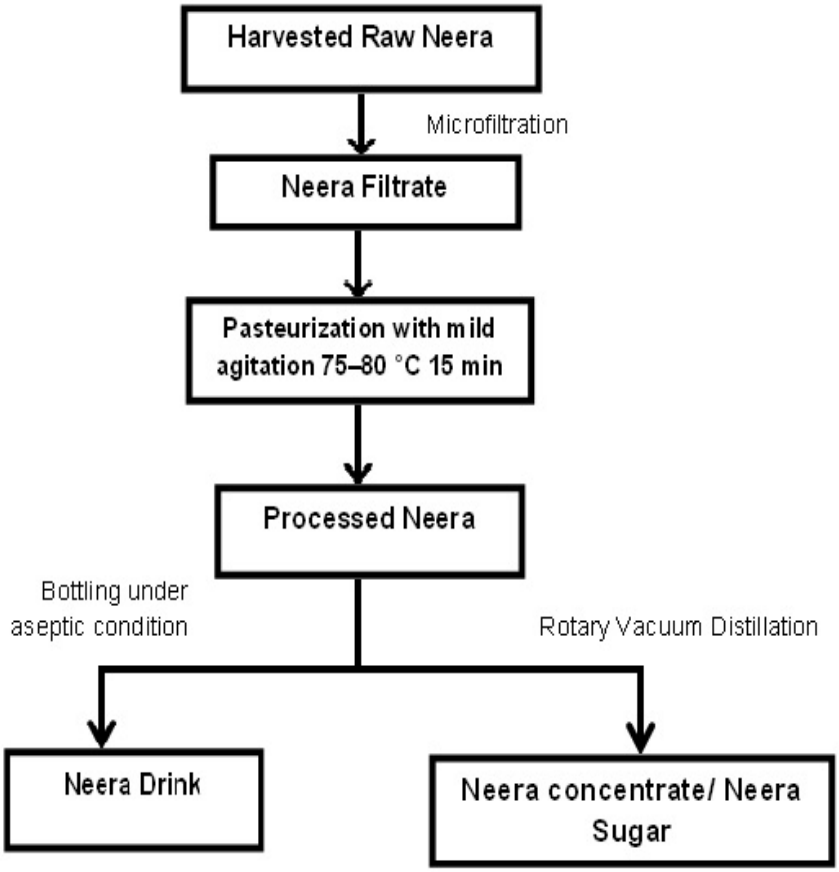

Figure 3. The processing of raw coconut Neera.

2.5. Estimation of Alcohol Content

The presences of ethyl alcohol in traditional Neera, Neera with AFS, processed Neera and Neera after storage were measured. The estimation was done colorimetrically using a sodium dichromate-sulphuric acid mix [8]. A standard graph of the ethanol content was prepared by taking an aliquot of stock solution at different concentrations. In the experimental part, an aliquot of Neera was taken, and the reaction was done by adding the reaction mixture consisting of sodium di chromate, sodium acetate buffer (pH 4.3) and 1N H_2SO_4 in the ratio 1:1:5. The control experiment was done by taking water instead of Neera in the reaction mix. The experiment and the control were incubated for 45 min after a vigorous shake for 1 min. The optical density was measured at 578 nm.

2.6. Estimation of Vital Nutrients

For determining the nutritive value of Neera as a health beverage, the level of primary nutrients was quantified by following the standard protocols [9–13]. Lipid profile: The lipid profile was analyzed by the gas chromatographic technique to determine the presence of unsaturated and saturated fatty acids [14,15]. Total carbohydrates (TC): The estimation of TC in Neera was done by following the Morris–Anthrone method with a modification in the sample preparation method so that it can be adapted to use on food [16,17]. A 10 mL anthrone reagent was added to 5 mL of sample Neera. The solution was mixed and allowed to stand for 10 min. The colour developed was measured at 540 nm in a spectrophotometer. A blank containing distilled water and standards containing 1–6 mg glucose/100 mL of solution were run parallel [18]. A sugar profile analysis was done to determine the presence of monosaccharides and disaccharides using high performance liquid chromatography-refractive index detector (HPLC-RID) [19]. Mineral content: The mineral content in Neera was analyzed using inductively coupled plasma mass spectrometry (ICPMS) and

atomic absorption spectrometry by following the guidelines in the manual of methods of analysis of foods: metals [20]. Amino acid profile: The essential amino acids present in Neera were identified and analyzed using liquid chromatography [21,22]. Vitamins: The vitamins present in Neera were determined using the liquid chromatographic technique following the test methods elaborated in the first edition of vitamin analysis for the health and food sciences [23].

2.7. Oral Toxicity Test and Glycemic Index of Processed Neera

An oral toxicity test was done for processed Neera to detect the toxicity level. The extract was administered at 5000 mg/kg to female Albino Wistar rats as the starting dose, and dosing of further animals for additional test dose levels was based on the 48-h survival pattern of previously dosed animals up to that time. On the day of dosing, the animal was observed for mortality and clinical signs for first 10 min, 30 min, 1 h, 2 h, 4 h and 6 h after dosing and thereafter once a day for 14 days. The body weights of the rats were recorded, and the weekly body weight gains were calculated. After 14 days of observation, all surviving animals were sacrificed and subjected to complete necropsy. This study was performed as per the Organisation for Economic Co-operation and development OECD guideline for the testing of chemicals [24].

The glycemic index of Neera was evaluated using the Dextrose from HiMedia and the glucose assay kit from Merck India Private Limited, Mumbai. Six rats were allotted to two groups, three in each. Group I served as the glucose control (dextrose prepared as 1 g/kg rat body weight). Group II served as the test group (Neera concentration; 1 mL/kg rat body weight). The animals were fasted for 12 h prior to test substance administration but had free access to water. The glucose levels were estimated using the glucose assay kit at various time intervals (0 min before the test substance administration and 15, 30, 45, 60, 90 and 120 min after the test substance administration). The data were analyzed to get an incremental area under curve (IAUC), and the glycemic index was calculated using following formula: (IAUC of the Neera/IAUC of the glucose) $\times$ 100.

2.8. Production of Value-Added Products

The development of value-added products from the processed Neera has a lot of industrial value in the food industry at a global level. Hence, two value-added products were developed using the processed Neera.

(i) Neera Concentrate: Neera concentrate—commercially called Neera squash—was developed by concentrating the Neera drink from a brix value 14 to 45–50 using rotary vacuum distillation under controlled temperatures.

(ii) Neera Sugar: The process of making Neera sugar was similar to that of the Neera concentrate. At the level of getting the Neera concentrate of a brix value 45–50, it was again subjected to further vacuum distillation process until the brix value came to the level of 55–60 with a texture of a semisolid form. This semisolid Neera thick concentrate was transferred to a wide metal pan and kept in an incubator at 70 °C for overnight. After proper dehydration, the solidified Neera as white a Neera sugar was powdered in a blender and bottled.

2.9. Statistical Analysis

For the quality analysis of the sample, a statistical analysis was done to detect the means and standard deviations of both raw and processed Neera samples. Since, the duration of the study was for 2 years, the samples were selected at three months interval (90 days). Therefore, the quality analysis for 8 batches was done. The selection of 90 days was in order to check the shelf life.

3. Results

3.1. Tapping and Harvesting

Figure 2 demonstrates the modified tapping procedure of non-fermented Neera by using AFS during harvesting. Proper training was given to tappers for following all the modifications that were incorporated from the traditional tapping. From the initial level of the selection of healthy palms up to the final phase of collection of Neera, proper care was given in the addition of AFS, i.e., 10 mL/L Neera to the collection vessel before inserting to the cut end of the spadix.

3.2. Anti-Fermentation Solution: Mode of Action of AFS

A cumulative action was seen by CA and KMS in AFS. During the harvesting of Neera, CA lowers the pH of raw Neera to acidic level. In the acidic condition, KMS exhibits the property of suppressing the growth of bacteria and fungi in the harvested Neera, thereby preventing auto-fermentation. Since both CA and KMS are accepted food preservatives, it will be fully secure and will not make any biosafety issues during usage.

3.3. Processing and Bottling of Neera

The brix value of harvested Neera was found between 14 and 16, and the pH was at the range of 5.2–5.7. Figure 3 shows the processing steps of the harvested Neera. The raw Neera with AFS was carried to the Neera plant for further processing. As the first step, the raw Neera was micro-filtered to remove the impurities, and the filtrate was pasteurized with mild agitation at 75–80 °C for 10–15 min. The processed Neera was bottled under aseptic conditions either manually in a laminar hood or using an automatic filling device. The processed Neera was also used for making the value-added products like Neera sugars and concentrates. Periodic analysing of the pH, brix value, protein, sugar, minerals, amino acids and vitamins revealed that processed Neera can be kept at room temperature for more than 90 days without any quality change. Figure 4 displays the pasteurized Neera filled in glass bottles of 300 mL capacity.

Figure 4. Bottled pasteurized coconut Neera: (**a**) Neera filled in glass bottles of 300 mL capacity and (**b**) Neera filled in polypropylene (PP) bottles of 200 mL capacity.

3.4. Microbial Load of Raw and Processed Neera

The microbial load of raw Neera collected by traditional tapping was checked along with the processed Neera. Table 1 details the bacterial and fungal count as colony forming units (CFU) per mL in raw Neera with and without AFS. A rich load of bacterial count was observed in raw Neera, but the fungal count was negligible. In raw Neera with AFS, the bacterial count has shown a drastic depletion to the level of 10 CFU/mL from 102,000 CFU, which strongly indicates the successful effect of AFS. Moreover, the limited level of microbial load in raw Neera with AFS provides a strong indication of

the hygienic environment induced by the effect of the modifications during tapping and collection. The bacterial count of processed Neera after three months of storage was checked. No increase was observed in the bacterial count from the level of 10 CFU/mL as noticed in raw Neera with AFS. From the high rate of bacterial count in raw Neera at the time of harvest, it is advisable that raw Neera cannot be recommended as a drink without pasteurization. As per the international food standards the bacterial count (CFU/mL) was limited to a range of 100–1000 CFU for health drinks.

Table 1. The microbial load of raw coconut Neera with and without AFS.

Organism	Raw Neera without AFS	Raw Neera with AFS
Total Bacterial Count/mL (CFU/mL)	102,000	Less than 10 CFU
Total Fungal Count/mL (CFU/mL)	Less than 10 CFU	Less than 10 CFU

3.5. Alcohol Content

As an undesirable component of Neera by traditional harvesting, the content of alcohol in the modified harvesting method, i.e., Neera with AFS, was checked at each level. The value was compared to the Neera harvested by traditional tapping. Figure 5 demonstrates the alcohol content of Neera harvested traditionally, Neera collected in chiller device after tapping and the Neera with AFS. It is obvious that traditional Neera as well as chilled Neera showed the presence of alcohol. The Neera with AFS showed zero level of alcohol.

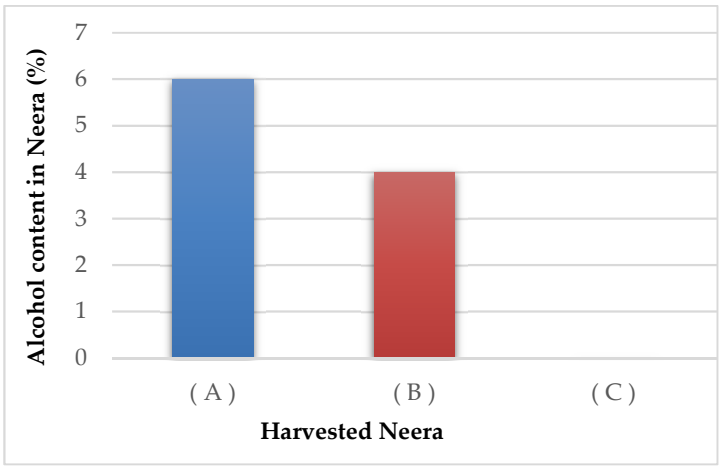

Figure 5. The percentage of alcohol content in coconut Neera. (**A**) Neera harvested traditionally; (**B**) Neera collected in chiller device after tapping; and (**C**) Neera with AFS.

3.6. Nutritional Composition of Processed Neera

The processed Neera was analysed at the macro and micro levels for determining the nutritional quality. Table 2 displays the level of primary nutrients like proteins, fats and carbohydrates and the food calorie of Neera. The data highlights the nutritive value of Neera as an energy drink for infants, youth and old people. The lipid profile demonstrates the presence of unsaturated and saturated fatty acids more or less in the same ratio at a minimum level (Table 2). Though the value of lipid constituents look negligible, the combination of unsaturated and saturated lipids showed an equal ratio of 1:1. The HPLC profile of total sugars shows the presence of three major sugars: glucose, sucrose and fructose. The fractions like arabinose, rhamnose, xylose, ribose, mannose and galactose were not found in Neera (Table 3). The Neera drink, as such, has a good combination of all the essential minerals with rich content of potassium, sodium, magnesium, calcium and iron. Table 3 exhibits the mineral content of Neera drink. The mineral content of Neera supports both the nutritive value of Neera and the therapeutic relevance of the drink towards mineral deficiency. The amino acid profile of

Neera showed content of all the essential amino acids needed to human system (Table 4). The higher content of arginine, cysteine and tyrosine indicate the need of using Neera by infants and growing children [25,26]. It is significant to note that the Neera drink is rich in vitamin C and the presence of Vitamin A as retinol and vitamin B2, B3 and B6 provides additional food values to Neera (Table 4).

Table 2. The proximate composition and lipid profile of processed coconut Neera.

	Components	Quantity/100 mL	S.D. Mean
Proximate composition	Food Energy	74.86 Kcal	0.51
	Protein	0.28 g	0.004
	Carbohydrates	18.03 g	0.03
	Fats	0.18 g	0.006
Lipids	Unsaturated fatty acids (Oleic & Linoleic acids)	80 mg	0.10
	Cholesterol	NIL	100 mg
	Saturated fatty acids (Lauric and Myristic acids)	NIL	0.47

Table 3. The sugar profile and mineral composition of coconut Neera.

	Components	Quantity/100 mL	S.D. Mean
Sugars	Glucose	1.5 g	0.02
	Fructose	0.6 g	0.02
	Sucrose	13.4 g	0.41
Minerals	Sodium	15.2 mg	0.05
	Potassium	100 mg	0.47
	Iron	0.36 mg	0.003
	Zinc	40 µg	0.11
	Magnesium	6 mg	0.01
	Calcium	1.8 mg	0.04
	Manganese	10 µg	0.04
	Selenium	10 µg	0.07
	Copper	27 µg	0.06

Table 4. The amino acid profile and vitamin content of coconut Neera.

	Components	Quantity/100 mL	S.D. Mean
Amino acids	Aspartic acid	4 mg	0.08
	Valine	2.19 mg	0.09
	Threonine	3.95 mg	0.07
	Alanine	2.78 mg	0.12
	Methionine	12 mg	0.66
	Leucine	0.47 mg	0.008
	Isoleucine	2.19 mg	0.02
	Histidine	99.6 mg	0.42
	Cysteine	14 mg	0.13
	Arginine	7 mg	0.14
	Tyrosine	7.11 mg	0.18
Vitamins	Vitamin B2	15.4 µg	0.51
	Vitamin B3	210 µg	0.78
	Vitamin B6	30 µg	0.56
	Vitamin C	65 mg	0.77
	Vitamin A (As retinol) (One IU Vitamin A is equivalent to 0.3 µg of retinol)	4.88 IU	0.15

3.7. Acute Oral Toxicity Data of the Neera Drink

The rats treated at 5000 mg/kg of the Neera extract survived throughout the study period. The treated rats exhibited no clinical signs following dosing and up to 6 h post treatment. The overall body weight gain was found to be normal at the end of 14-day observation period. No major gross pathological changes were observed in the treated rats. Based on the findings of the present study, the median lethal dose of Neera after single oral administration in female Albino Wistar rats was found to be more than 5000 mg/kg body weight. Hence the product was found absolutely non-toxic. Animals treated at the dose level of 5000 mg/kg body weight survived throughout the study period. These animals did not show any abnormal clinical signs following dosing and during the observation period of 14 days. The overall body weight gain of rat treated with 5000 mg/kg was found to be normal at the end of 14-day observation period. The treated animals exhibited normal weight gain during the study period. Macroscopic examination of the animals sacrificed at termination revealed no abnormalities. Histopathological examination was not conducted since no major gross pathological abnormalities were observed on necropsy.

3.8. Glycemic Index of Neera

The data was analyzed to get an incremental area under curve (IAUC), and a glycemic index was calculated using the formula: (IAUC of the Neera/IAUC of the glucose) × 100. Table 5 demonstrates the level of serum glucose at different time intervals in the presence of glucose and Neera. Table 6 demonstrates the mean of Incremental Area under Curve (IAUC). The glycemic index of the Neera was found to be 52.17. The lower levels of glycemic index favors its consumption for diabetic patients, but a more exhaustive therapeutic analysis is essential to substantiate the hypothesis.

Table 5. The mean values of serum glucose (mmol/L) in Albino Wistar rats treated with Glucose (1 g/kg rat body weight) and Neera (1 mL/kg rat body weight) over a time period of 0–120 min.

Groups		Serum Glucose (mmol/L)						
		O min	**15 min**	**30 min**	**45 min**	**60 min**	**90 min**	**120 min**
Glucose (1 g/Kg rat b.w.)	Mean	4.00	9.91	9.43	9.19	8.72	7.50	6.28
	S.D.	0.20	0.41	1.58	0.58	0.41	0.39	0.52
	S.E.M.	0.11	0.24	0.91	0.33	0.23	0.23	0.30
Neera (1 mL/Kg rat b.w.)	Mean	4.03	4.41	4.37	4.37	4.25	4.08	4.13
	S.D.	0.29	0.36	0.30	0.26	0.27	0.35	0.24
	S.E.M.	0.17	0.21	0.17	0.15	0.15	0.20	0.14

Table 6. The mean IAUC with standard deviation of Glucose (1 g/kg rat body weight) and Neera (1 mL/kg rat body weight)-treated Albino Wistar rats.

Groups		Increment Area under Curve
Glucose (1 g/Kg rat b.w)	Mean	973.25
	S.D.	46.00
	S.E.M.	26.57
Neera (1 mL/kg rat b.w)	Mean	507.76
	S.D.	35.08
	S.E.M.	20.26

3.9. Value-Added Products

Neera concentrate: As a natural drink with 80% water and all primary and essential nutritional constituents, one litre of Neera can be concentrated to 200 mL to make it a concentrate (Figure 6). Based on the texture of the Neera concentrate, it can be diluted to prepare a natural Neera drink by

dissolving it in water without adding sugar. The Neera concentrate can be used as a bread spread and for making cakes, jilebi, ladoo, biscuits, bread, etc. Neera Sugar: The texture of Neera sugar was similar to cane sugar with a white colour (Figure 7). However, the nutritional potential of Neera sugar is not at all comparable with cane sugar since it contains all the essentials of normal human growth.

Figure 6. Coconut Neera concentrate (squash) developed from processed Neera.

Figure 7. Coconut Neera sugar prepared from the concentrate.

4. Conclusions

As a unique physiological status, coconut palms can provide four natural health drinks like Tender Coconut Water, Mature Coconut Water, Coconut Neera and Sweet Toddy. Though, the coconut water and Neera exhibit varied in nutrient value, the uniqueness of sweet toddy stands on its alcohol content. Since, the quality of Neera is highly perishable due to the auto-fermentation leading to the formation of alcohol from the level of harvesting during traditional tapping, a cost-effective scientific approach is inevitable for suppressing the undesired fermentation of raw Neera. The results of the present investigation highlight the production of non-fermented Neera with a prolonged shelf life of six months at room temperature by a modified tapping protocol. A combination ratio of the preservatives—Citric Acid and Potassium Metabisulphite—worked effectively as an anti-fermentation solution for preventing the fermentation within the palm itself during harvesting. The analytical data of processed Neera confirmed it as a perfect vital health beverage compared to other natural green drinks. With respect to the mineral composition, amino acid profile and vitamin content, it would be possible to exploit this natural drink in the clinical therapy of mineral and amino acid deficiency. More studies are warranted for accepting Neera as a popular green drink at international level. Moreover, a consortium of coconut growing countries is essential for revealing the nutritional merits of this wonderful gift of coconut palms.

Author Contributions: Conceptualization, supervision, validation and funding acquisition, M.C.; supervision, formal analysis and project administration, S.B.; methodology, investigation, data curation and writing, M.B.H.; investigation, D.S.; methodology, H.M.

Funding: This research was partially funded by the Coconut Development Board (CDB), Ministry of Agriculture and Farmers Welfare, Government of India and the SCMS Institute of Biosciences and Biotechnology Research and Development (SIBBR&D), Cochin, Kerala, grant number F.No. 1345/2012/Tech-SCMS III.

Acknowledgments: The authors gratefully acknowledge the Coconut Development Board (CDB), Ministry of Agriculture and Farmers Welfare, Government of India for the funding of the project. We are thankful to Gopalan Unnithan Prathapachandran Nayar(Chairman) and Pramod Prathapachandran Thevannoor (Vice-Chairman) of the SCMS Group of Institutions for providing the essential infrastructure for carrying out the investigation successfully. The authors are indebted to Department of Excise, Government of Kerala, India for providing the license of tapping.

Conflicts of Interest: The authors declare no conflict of interest.

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An Investigative Study on Export Performance of Gems and Jewellery in India

Dr. RESHMI A.RAJAN, Associate Professor, SCMS School of Technology and Management, Cochin, Kerala, India. reshmirajan@scmsgroup.org

Abstract - The Indian gems and jewellery industry is one of the fastest growing industry in the world. India is acting as a prominent country related to diamond polishing and jewellery work due to traditional, customs and cultural background of the society. The gems and jewellery are classified as polished diamond, Gem stones, Gold & Jewellery and synthetics stones. India is a world largest gold importer and a consumer in terms of ornaments comparatively other developed and developing countries. The demand of the gold day by day increasing in India due to marriage, culture, customs and devotional aspects as well as gold is acting as a major investment options in among the rich and middle class people in India. The export industry has come of age and is now entering a new phase of development. Gearing up to achieve further growth, the industry has already captured a 55% share of world market in terms of turnover of this century. With consumer consciousness increasing towards trendy jewels design in among youngsters, the future of organized jewellery market in India is very bright. The organized sector of the gems and jewellery industry in India is estimated to grow at 40 per cent per annum to US$ 2.2 billion by 2023. India is acting as a primary source of imports for the developed countries, due to availability of skilled and cheap labor, but now this no longer remains the competitive edge for India as heavy competition is faced by various countries like China, Thailand and Sri Lanka. But at the same time, India has managed to keep its position healthy and have brighter prospects ahead.

Keywords: Gems and jewellery, Diamond, stone, world market, cheap labor and quality design.

I. EXPORTS

Exports during the April-December 2013 period, increased to US$ 19.20 billion from US$ 19.6 billion a year earlier. Exports of cut and polished diamonds in the April-December 2013 period stood at US$ 12.20 billion as compared to US$ 12.06 billion in the corresponding period in the previous year.

STATEMENT OF THE PROBLEM

The researcher observed that, there is a wide research gap between actual position of Gems and Jewellery market in India and research outcome related to this sector. Gems and Jewellery market nature is very complex in terms of fluctuation of currency, gold rate, demand and Government policy. This present study is tried to find out of the performance of Gems and Jewelleries in India with the help of appropriate statistical tools.

OBJECTIVE OF THE STUDY

The researcher has framed three objectives of the study, like to observe the present status of the Indian gem and jewellery sector and to analyze the present export performance of Gem & Jewellery from India as well as to predict the future Export performance gem and jewellery sector in India.

PERIOD OF STUDY

The period of the study is covered from 2007-2008 to 2012-2017 and further, it is projected up to 2023.

SCOPE OF THE STUDY

The researcher has chosen this area as a study area to find out the present and future performance of gems and jewellery industry in Indian context. It will help to improve the existing export volume of Gems & Jewellery industry area as well as useful to know the future market of gems and jewellery industry in the world market.

II. RESEARCH METHODOLOGY

SOURCE OF DATA

The study nature is desk research, based on the secondary data sources. The present study is constructed with the help of published details related to gem and jewellery in Indian market through internet, journals, magazines, newspapers etc.

STATISTICAL TOOLS AND TECHNIQUES

The researcher has used the trend analysis (y = a plus bx) and percentage growth method (Growth rate = present – past/ past x 100) as well as plus or minus changes method for converting the raw data in to meaningful data.

 DOI : 10.18231/2454-9150.2018.1113

LIMITATIONS OF THE STUDY

As per the researcher concern, the following short comings are observed by the researcher in this present study, it includes the time duration for the data collection is short period from February 2018 to June 2018. This present study is constructed based on the ministry of commerce published data as well as few articles related to the study area. Further accuracy of the data is not considerable since it is secondary in nature.

III. RESULTS AND DISCUSSION OF THE STUDY

TABLE NUMBER: 01 Export of Coloured Gem Stone from India to World Market from 2007- 2023

Year	Value in US $ in Million	Growth percentage
2007-08	249.44	-
2008-09	226.34	-9.26
2009-10	241.42	6.66
2010-11	257.19	6.53
2011-12	268.02	4.21
2012-13	290.07	8.22
2013-14	289.80	- 0.09
2014-15	299.63	3.39
2015-16	309.46	6.62
2016-17	319.29	3.17
2017-18 **(Projected)**	329.11	3.07
2018-19	338.94	2.98
2019-20	348.77	2.91
2020-21	358.61	2.83
2021-22	368.44	2.75
2022-23	378.27	2.67

Source: Ministry of commerce & industry.com

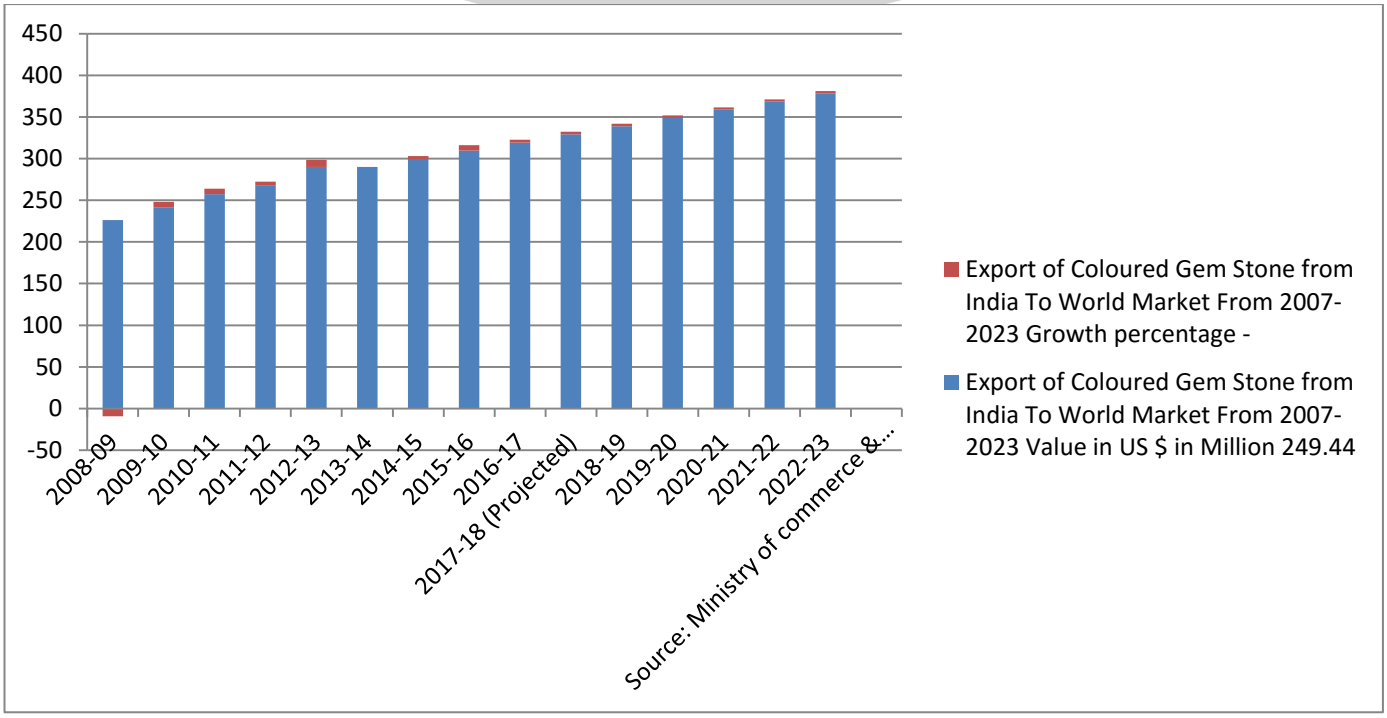

TABLE NUMBER: 02 Total Export of Gold Jewellery from India to World Market from 2007 TO 2023

Year	Value in US $ in Million	Plus or minus changes
2007-08	4550.39	-
2008-09	4252.52	+
2009-10	5601.2	+
2010-11	7375.74	+
2011-12	8657.72	+
2012-13	7755.54	_
2013-14	9467.11	+
2014-15	10353.3	+
2015-16	11239.4	+
2016-17	12125.6	+
2017-18 **(Projected)**	13011.8	+
2018-19	13897.9	+
2019-20	14784.1	+
2020-21	15670.3	+
2021-22	16556.4	+
2022-23	17442.6	+

Source: Ministry of commerce & industry.com

IV. OBSERVATIONS OF THE STUDY

- India processes over 57% of world's rough diamond value, it is said 11 out of 12 (diamonds) set in jewellery are cut and polished in India.

 DOI : 10.18231/2454-9150.2018.1113

- It is observed that, as per the growth percentage there is steady progressive going on related to coloured Gem stone from India to world market. Meanwhile, as per the plus or minus changes method stated that there is a constant over the export of gold jewellery from India to world market.
- As per forecasts, by the year 2023 the industry will witness a good fragmentation in the jewellery retail business while keeping the area of diamond mining, sourcing, processing within the confines of either niche or mass player.
- GJEPC is continuously working towards creating a pool of artisans/designers trained to international standards so as to consolidated the Indian jewellery industry and establish it as a prominent global players in the jewellery segment.
- GJEPC undertake direct promotional activities like organizing joint participation in international jewellery shows, sending and hosting trading delegations and sustained image building exercises through advertisements abroad, publication and audio-visuals.
- GJEPC runs a number of institutes that provide training in all aspects of manufacture and design in Mumbai, Delhi, Surratt and Jaipur.
- According to Credit Analysis and Research Limited (CARE), the domestic jewellery market in India is pegged at US$ 16 billion in the year 2023.
- India consumes nearly 800 tons of gold accounting for about 20 per cent of the world gold consumption in all over the world.
- The Government of India allows100 per cent foreign direct investment (FDI) in gems and jewellery through the automatic route.
- Export of gems stones showing an increasing trend for the future year up to 2023.
- Export of gold jewellery showing an increasing trend for the future year up to 2023.

V. RECOMMENDATAIONS OF THE STUDY

- More patterns & designs could be implemented in order to improve the industry in near future.
- The Government of India could undertake more measures to utilize the funds effectively to develop the gem & jewellery market.
- The various trade fairs, exhibitions and trade shows could be conducted to increase the turnover of the gem & jewellery industry.
- The proper training must be provided for the industries to develop the excellence in terms of quality work.
- The advancement in the technologies has to be updated, in order to compete in the global market.
- The duties levied on the gem & jewellery could be lowered to encourage the players in the market.
- The GOI must encourage the domestic exporters and help them to export gems and jewellery product in International markets for acquiring more foreign exchange reserve.
- The GOI must simply the complicated export procedure followed in the Gems and Jewellery export for increasing the volume of export in near future.

VI. CONCLUSION

India has been one of the most important countries for the production of Gems and Jewellery. One of the highlights is the production of Studded Jewellery. Studded Jewellery trading in India is age old as it is established by the fact that in 1650 A.D., sources report the employment of more than 60,000 workers in the Eluru mines, where they dug and washed the precious stones. Today though India has almost no raw Studded Jewellery left within India, the Indians are producing 70% of the World gems in terms of quantity and 45% in terms of value. India is the original country which discovered gems and initiated gem craft. Indian Gems and Jewellery Industry have achieved a premier position in the International market. Today India has been recognized as a significant manufacturing exporting center apart from its traditional strengths in handmade jewellery; the country has rich for itself in machine made commercial jewellery arena. India is the largest manufacturer of cut and polished diamonds in the world and exports 93 per cent of its production. India exports 75 per cent of the world's polished diamonds as of 2016.India's share in the world diamond market is 60 per cent in terms of value 90 percent in volume. At present 12 out of 14 diamonds prepared and sold by Indian o world market either polished work or cutting work. India's gems and jewellery sector is one of the biggest the world marketing contributing 29 per cent to the international jewellery consumption. The sector nearly 300000 players are involving with this work director and indirectly. Its market size is about US$ 54.58 billion of which 55 per cent is accounted by the unorganized sector dealing with sector the export industry has come of age and is now entering a new phase of development. Gearing up to achieve further growth, the industry has already captured a 55% share of world market in terms of turnover of this century. India is acting as a primary source of imports for the developed countries, due to availability of skilled and cheap labor, but now this no longer remains the competitive edge for India as heavy competition is faced by various countries like China, Thailand and Sri Lanka. But at the same time, India has managed to keep its position healthy and have brighter prospects ahead. As per the study found that, there is a continuous increase in the export of Gems and Jewellery in India. Therefore, the GOI must take necessary steps to retain as well as sustain the export performance of gems and jewellery in near future for enriching the export volume of India.

 DOI : 10.18231/2454-9150.2018.1113

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The consumer experience on geographical indicators and its impact on purchase decision: An empirical study

Thangaraja.A[1], Abirami.A[2]
[1]SCMS School of Technology and Management, Kochi, Kerala
[2]Lead College of Management, Palakkad, Kerala

Abstract

Nowadays, the global competitive environment deals with the quality products so they can attract their consumers and also they can differentiate their products from others. A Geographical Indication (GI) is a name or sign used on products which corresponds to a specific geographical location or origin. In this paper, we investigate about the consumers' behavioural impact on the purchase decision after consuming the Geographical Indication Products. When it's coming to the purchasing behaviour of a consumer may depends on various factors that may influence the decision making process such as physical pleasure, income effect, price effect, reference group, culture, social class, choice of a product, brand and dealer or store, purchase timing and amount, perception, and post purchase behaviour, etc., All factors are dependent on each other and influence the decision making process of a consumer. But the purchasing of the geographical indication is made by the consumer by their locality, tourism places, obtain information from different sources, have different perceptions, have differing satisfaction levels related to past experience, etc., Thus the purchase decision is dependent on many factors. These factors may be specifically related to products.

There is an evident that the models have goodness of fit and the model is statistically tested with CFA of each constructs and then overall fitness. The customer experience has a positive impact on customer experience, this relationship is mediated by the GI. When the customer is having positive experience, he is about to make positive purchase decision. This is favourably influenced by the mediator GI.

Key Words: GI, Customer experience, customer purchase decision

1 Introduction:

Regarding the decision – making process of a consumer, this article contributes to find if there is any impact while purchasing the products which are indicating the trademark of every places or origins. The present paper dealing with the geographical indicators and the marked effect on the consumer – purchase decisions. Nowadays, the global competitive environment deals with the quality products so they can attract their consumers and also they can differentiate their products from others. A Geographical Indication (GI) is a name or sign used on products which corresponds to a specific geographical location or origin. This may act certification of the product and also with qualities, which are made with traditional methods, and have the original taste, flavours, and have some reputation because of the geographical region. The characteristics of a product determines the extent of its short-term and long-term impacts on its environment. The trademarks or trade names of a product results monopoly competition in the markets. Because the trademarked products are manufactured in their geographical origin. Geographical indications are generally traditional products, produced by rural communities over generations that have gained a reputation on the markets for their specific qualities. This type of markets is run by the traditional community producers and also they only investing on their own products because it was their traditional and origin which may help to build the reputation of their products. The rural development is involved in this Geographical Indications (GI) by structuring the supply chain of the trade products, added value for their products by the traditional manufacturing. The trademarked products always have added values in the market and among the consumers because a geographical indication cannot be sold, purchased, transferred, licensed, pledged, mortgaged or put to such other agreement not by this conditions also involves the reputation, traditional methods, and have the culture on the products. There are many features of geographical indication while marketing the manufactured products from their origins.

In this paper, we investigate about the consumers' behavioural impact on the purchase decision after

consuming the Geographical Indication Products. When it's coming to the purchasing behaviour of a consumer may depends on various factors that may influence the decision making process such as physical pleasure, income effect, price effect, reference group, culture, social class, choice of a product, brand and dealer or store, purchase timing and amount, perception, and post purchase behaviour, etc., All factors are dependent on each other and influence the decision making process of a consumer. But the purchasing of the geographical indication is made by the consumer by their locality, tourism places, obtain information from different sources, have different perceptions, have differing satisfaction levels related to past experience, etc., Thus the purchase decision is dependent on many factors. These factors may be specifically related to products.

2 Aim of the Study

To determine the difference between general product consumers' experience and their purchasing decision and the geographical indication consumers' experience and their purchasing decisions after consuming the GI products.

To create a model for the post purchase behaviour of a consumer by purchasing the GI products and the impact or effect while purchasing the same products which do not have the GI.

3Review of literature

(Dwijen Rangnekar,2004)The linkage of Intellectual property and the national development has been emphasised in the paper does not hold in all the cases though it has been supported by different evidences. on the other hand, the role, impact and evidences of Geographic Indications and the intellectual property on the innovation and growth level of developing countries have been really analysed and the conclusion in this part is of great importance. This paper has divided the goods into three categories of search good, experience good and credence goods that have an influence on the economics of geographic indications. IGO is defined as a collective monopoly right that is focussing on the integrated supply chain. The retailers have been given greater importance and the idea that retailing will dominate the supply chain is a comparative statement where it won't be the same in some regions of the world. The role of GIs in protecting the indigenous knowledge has been overemphasised because countries in the west has protected the knowledge without protecting the GIs.

The paper written by (Kasturi Das,2007) points a very valid statement of the historical ability of India to have Geographical indications, but the inability to register and protect such intellectual properties have been because of many reasons, among them, one is the absence of legislations in this regards. India can be one of the best countries for having GIs and protections of GIs. For a country like India, it is not appropriate to have problems in the field of GIs, but we have a list of problems that GIs face. To start with, India has the challenge of foreign registration and brand building as the core challenges and the sharing the benefits that my rise out of GIs is a second phase problem. Most of the countries have utilized their cultural values to promote their GIs and India being a rich country from the culture point of view is still having problem with the marketing and promotion of its GI products. India can use its culture to brand the GI products and it has a long way to go global with the same products. Going global with GI products seems to be easy for India if companies try to comply the quality, integrity and consistency requirements of the GI Act. The coordination among government departments to protect GI will increase the cash flow within the country and the socioeconomics of the country will be in favour. The artisans and promoters of GI products could have a better business positions in case they consider the importance of capacity and preparedness of the country.

Retailing is the most dominant part of the supply chain in any industry in today's corporate world. It is gaining significance day by day and its proper management is a necessity. Rattail store that sells products under their own brand and not the manufacturing brands are growing in number almost every day. The researcher studies the behaviour of Scottish and Greek buyers towards retailers' own brands. It is found that own brands are perceived with higher quality where the choice of purchase is also influenced by the other factors such as price and packaging. The difference in perception of people bout own brands in Greece and Scotland reveals that there are some regional differences while making decisions about own branding in retail business. Own branding may be accepted by the buyers in some countries and may not be welcomed in some others. Studies show that retailing is gaining more significance and the buyers attach more quality to own brands. Cleopatra (Veloutsou Evangelos Gioulistanis and Luiz Moutinho, 2004) are in the believe that brands are the source of competitive advantage for companies.

(Felix ADDOR and Alexandra GRAZIO,2002) have spoken about the protection provided for GIs under the article 22 and Article 23 of TRIPS. Countries of the world are not willing their GI products to be used by other countries and they want to protect their GI products. This has led the countries to provide protection for GIs in the WTO TRIPS Agreement. The protection provided in TRIPS are not enough and countries should make sure to enforce their laws as good as possible to ensure the proper utilization of their GIs.

(Diane Halstead and Cheryl B. War,1995) Here the study is on the changes in the private label brands. The author has also referred to the wheel of retiling theory to see whether the new changes are falling into a cycle like that of the wheel theory or not. The result of his research shows that we cannot fully reject the wheel of retiling hypothesis as far as we discuss about the private label brands. According to him the vulnerability of private label brands is due to competitive reactions of national brands and the failure of private label brands may not be because of

the strategic mistakes of the firms. to compete with national brands, the firms must evaluate their current marketing strategies. The national brands can coupon with the private brands. This study does not differentiate producers private label brands and retailers who offer their own private brands. The study does not answer to this question also; are private label brands modifying their strategies as a result of increased competitive responses from national brands, or are they initiating strategy changes on their own?

(Mark S. Glynn,2009) the proneness of buyers to buy Private Label brands are influenced by the factors such as brand loyalty, price, quality and price-quality association. The moderators of private label brands are income, household size and education. Moreover, it emphasises the consideration of product category differences while generalizing bout private label brands.

(Ramona Teuber,2011) This report indicates that the consumers have very limited knowledge about the Geographical Indications and their level of awareness is low about the GIs. Consumers are not mush aware and hence are not ready to pay any premium for the protection of GIs, and their hypothetical willingness to pay for protection is mainly based on their perception about the positive impact of geographic indications on the local economy. On the other side, the producers are motivated to apply for protected GI products only to secure the established reputation against misuse by competing producers to ensure quality level of their own product. The final result of this paper emphasises the communication of protected GI products to the consumers in order to reap the benefits.

An Overview of Select Issues with Particular Reference to India

(Kasturi Das,2010) This paper studies the issues of Indian companies in regard to GI registration and protection of GIs in India. The identification of the products eligible for protection as GIs, the practical implication to assess the commercial status/prospect of a GI product in the domestic and export markets; the socio economic implications and the potential for the future growth of GI Products are the major issues. To overcome these issues, the author has given solutions such s identifying the proper consumer segment, effective enforcement of GIs in relative markets, registration of GIs and focusing on rural developments are discussed about. However, the research has suggested more studies on the ground realities of the GIs s Indi is already doing comparatively good in the area of GI products based on its presence in the world's market.

4. Research Methodology

This study was conducted among the FMCG users in Kochi with the aim of understanding their experience on GI products and its impact on purchase decision. The survey was conducted among 224 customers whose experience have been assessed through customer experience scale (Kamaladevi, 2009) and GI scale and its impact on the customer purchase decision. The conceptual model have been analysed using SEM by AMOSS.

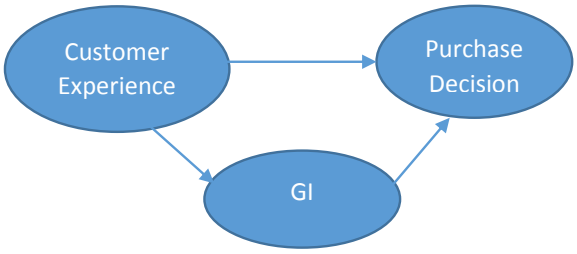


Figure1: Conceptual Framework

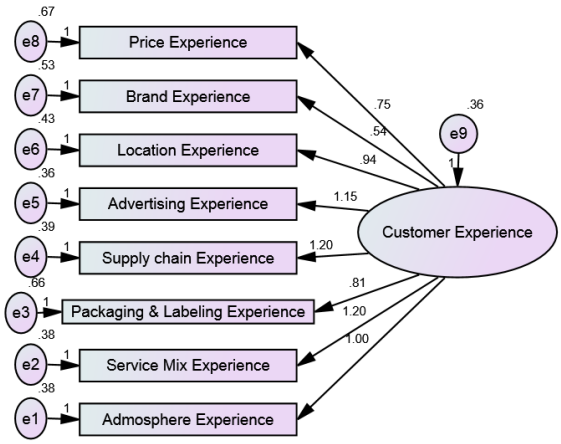
5Discussion

The CFA was run to identify the item suitability with the constructs namely Customer experience, Purchase decision and Geographical indicators. In this model, Independent variable is customer experience, purchase decision is taken as dependent variable and the GI is mediating variable. The Structural equation model is adopted to identify the impact of customer experience on purchase decisions and its changes while mediator (i.e., GI) is present.

The structural equation model has two components namely CFA for construct and item fitness and second component is to identify the path analysis and its coefficients.

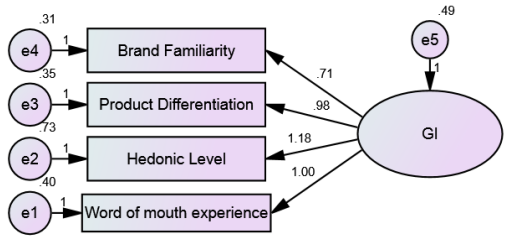
Confirmatory factor analysis

Confirmatory factor analysis is conducted separately for the two constructs that are customer experience which consist of 8 items and GI that includes 4 items. The result of the CFA for each constructs and the overall measurement model for CFA is also denoted here.



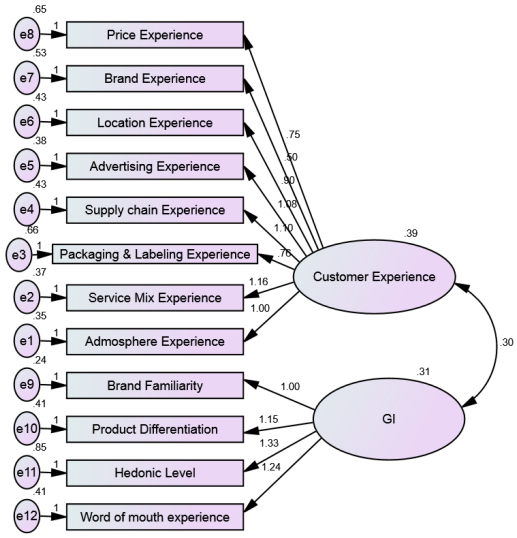
Chi square= 69.913 ,DF=20,RMSE=0.093,P Value= .000

Figure2: The CFA for Customer experience construct



Chi square= 4.465 ,DF=2,RMSE=0.066,P Value= .107

Figure3: The CFA for Geographical Indicators



Chi square= 183.33 ,DF=53,RMSE=0.093,P Value= .000

Figure4: Overall CFA of measurement model

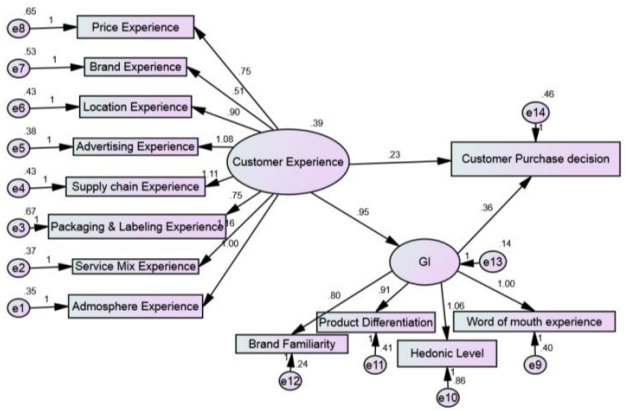
The Measurement model for all constructs are assessed and validated through CFA. The overall measurement model has been displayed in Figure 4, displaying the reliability of the observed items and scale used to measure the geographical indicator and customer experience.

Table 4 Results of Goodness of Fit Test for Confirmatory Factor Analysis

Model	Normed Chi-squre (χ^2/df)	P-Value	GFI	AGFI	CFI	NFI	RMESA
Study model	183.33	0.0	0.91	0.84	.89	.96	0.04

The normed chi-square is 183.33, GFI is 0.91, AGFI is 0.84, NFI is .96, RMSEA is 0.04 and CFI is 0.89. The overall fitness is acceptable and constructs are rightly fit with the items of the respective constructs. There are two constructs and the overall loadings are satisfactory in this model.

Chi



Chi square= 208.87, Df=63 , P value = .000

Figure 3: The impact of GI in the relationship between customer experiences on purchase decision

Goodness of Fit index of the GI model for customer experience is enumerated for the understanding of the path coefficients and its loading. Chi square= 208.87, Df=63 , P value = .000 , RMSE= 0.42 denotes the residual presumes acceptable in this model , GFI=0.92,CFI=0.87 indicate that the path model is good fit with high level of Goodness index and less error values.

6Conclusion

The study is initiated with the view to explore the relationship between the customer experience on its impact on Geographical indicators and its effect on customer purchase decisions. There is an evident that the models have goodness of fit and the model is statistically tested with CFA of each constructs and then overall fitness. The customer experience has a positive impact on customer experience, this relationship is mediated by the GI. When the customer is having positive experience, he is about to make positive purchase decision. This is favourably influenced by the mediator GI.

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