

ISSN 2583 – 2115

VSIT's

Pradnya

International Journal of Multidisciplinary Research

Volume: 01

Issue Number: 01

April-September- 2021



Pradnyaa International Journal of Multidisciplinary Research

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Mumbai 400037

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Karnavati University

Gujarat 382422

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Non-invasive Glucometers-Painless way for regular tracking of blood glucose

Ms. Amraja Shivkar

Assistant Professor,

Department of Information Technology,

Vidyalankar School of Information

Technology, Wadala.

Email: amraja.shivkar@vsit.edu.in

Mobile: 9833417442

Ms. Maitreyi Joglekar

Assistant Professor

Department of Information Technology,

Vidyalankar School of Information

Technology, Wadala.

Email: maitreyi.joglekar@vsit.edu.in

Mobile: 9975879393

ABSTRACT

In today's stressful life in which maintaining a healthy lifestyle is a big challenge as well as necessity, a disease like Diabetes has become one of the health concerns around the globe. Keeping the healthy blood glucose levels is beneficial for the prevention of diabetes. This requires regular monitoring of blood glucose. The conventional method used for glucose monitoring is painful as it involves finger pricking and testing the collected blood samples. This may also cause infection if the needle used for pricking is not sterilized or if it is used one. These factors may cause fear in the patients and hence resulting into reluctance in monitoring the blood glucose. This paper deals with the various technologies used for non-invasive monitoring of the blood glucose

Keywords: Non-invasive, spectroscopy, iontophoresis, diabetes, metabolic

1. INTRODUCTION

1.1 BACKGROUND-

As per the International Diabetes Federation, there are 463 million adults worldwide with diabetes. The total number of people with diabetes is predicted to rise by approximately 50% in next 20 years. As per the survey carried out by World Health Organization, diabetes is one of the leading causes of death across the world.

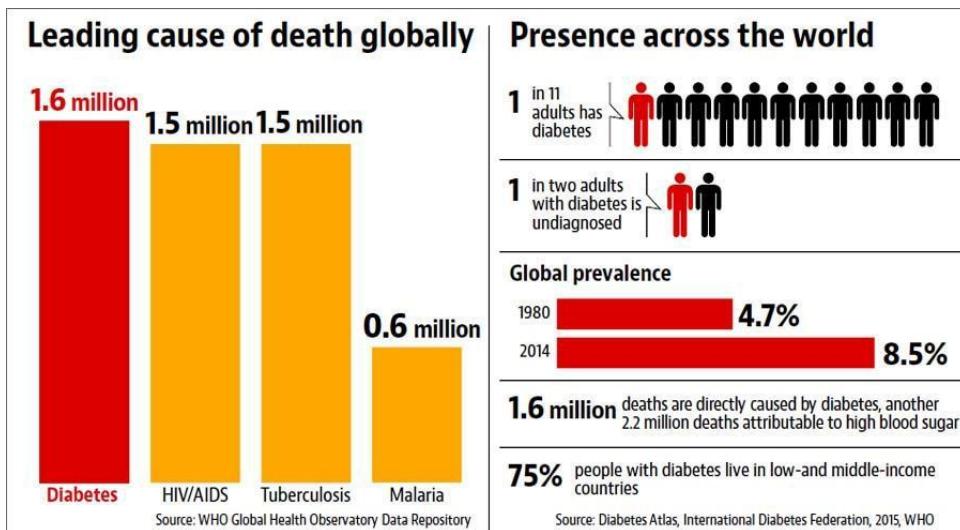


Fig.1 Diabetes Survey

There are certain consequences of diabetes such as over the time diabetes can cause heart conditions. It can also cause damage of blood vessels, vision, kidneys, and nervous system.

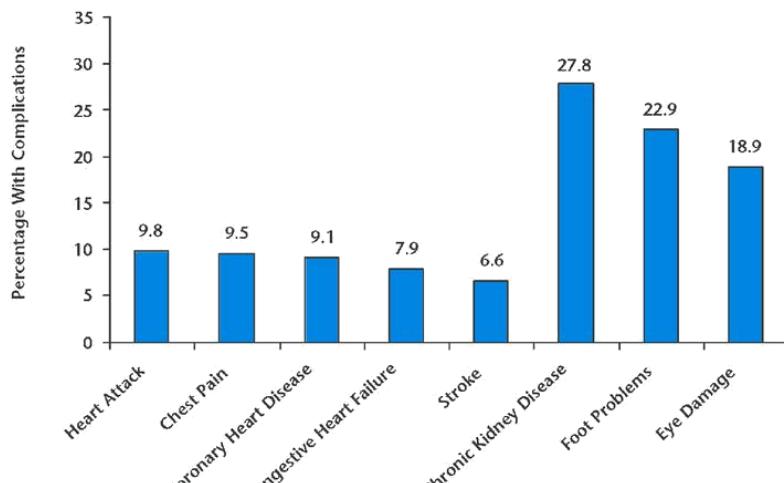


Fig.2 Diabetes Related Complications

To prevent these complications in future, diabetes patients need to monitor their blood sugar level regularly. This regular monitoring can help patients and their doctors to decide the dose of medicines, diet, exercise routine, etc., which in turn will minimize the risk of complications mentioned above.

1.2 SELF-MONITORING OF BLOOD GLUCOSE (SMBG)

Self-Monitoring of Blood Glucose (SMBG) means diabetes patients measure their blood sugar level themselves using a glucometer. This SMBG approach can be followed by patients to monitor their degree of diabetes on a regular basis.

As per the American Diabetes Association, the table below indicates how frequently one should monitor the Blood Glucose levels [4].

Situation	Recommended self-monitoring times and frequency
Patients taking daily insulin injections or insulin pumps	At least 3 times daily (Before meal, after meal, before Bedtime).
Patients with type 2 diabetes taking insulin secretagogues.	Twice in a week.
Newly diagnosed with type 2 diabetes	At least 1 time a day (to check effects of various meals and medication)
Patients with type 2 diabetes taking antidiabetic medication with no hypoglycaemia or lifestyle risks.	Once in week or two weeks

Even though it is necessary to monitor the blood sugar levels frequently to enhance the self-care, people are quite hesitant about SMBG. There are certain reasons behind that such as

- the cost of test strips and needles which are used for the test
- frustration of getting high blood glucose reading
- fear of needles, fear of frequent skin pricking

- inconvenience to use the glucometer at workplace
- lack of self-efficacy and knowledge.

2. NON-INVASIVE GLUCOMETERS

NIR Spectroscopy says that the correlation between the photodiode output voltage and the glucose concentration is directly proportional to each other. So, by using Polynomial Regression we can predict the glucose concentration value by passing the voltage value to the equation. Here we are using scilab software for the regression process. The initial voltage reading is derived by Multimeter.

To form a non-invasive glucose monitoring system, it is important to calibrate that system with the help of the conventional method of glucose monitoring. For that different known samples are taken into consideration. Voltage values from different known samples are compared with glucose level measured by conventional method of testing blood glucose. The method of regression is used in algorithm for calculating blood glucose level of unknown samples. In non-invasive methods to achieve the voltage value from samples different sensors can be used. Some of which are discussed in this paper.

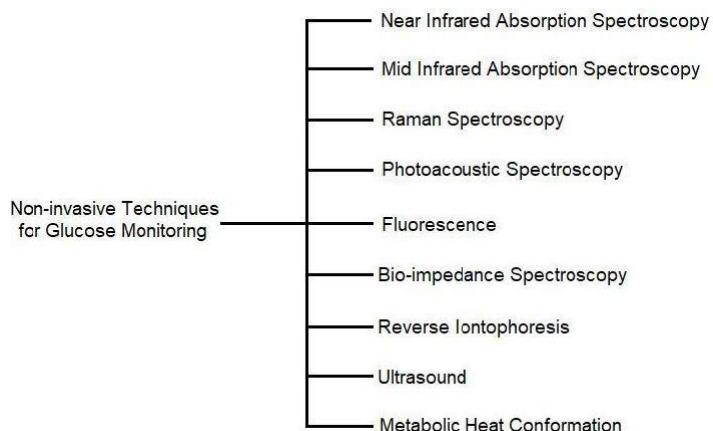


Fig.3 Different Non-invasive Techniques for glucose monitoring

1. Near Infrared absorption spectroscopy:

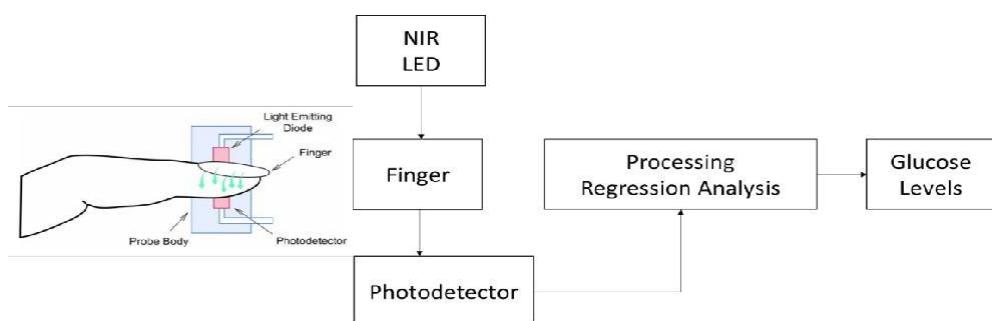


Fig.4 Near Infrared Absorption Spectroscopy for glucose monitoring

Near-infrared region of the electromagnetic spectrum has a wavelength from 780 nm to 2500 nm. In general, IR rays passing through a liquid sample are absorbed by a compound to be tested, and samples are identified based on difference in their absorbing capacity. It is based on collecting absorption spectra of the tissue with a spectrophotometer. The IR light is focused on the body which then gets partially scattered and absorbed. Tissue properties and characteristics are then measured by light attenuation resulting from absorbance and scattering properties. Changes in the absorption

corresponding to water displacement or difference in its intrinsic absorption change the glucose concentration, which in turn changes the measured absorption coefficient. The intensity of light which is scattered by the tissue is also affected by changes in glucose concentration. In order to check glucose level by NIR spectroscopy, the best site is forearm skin, earlobe, cheeks, tongue and nasal septum or lip mucosa.

2. Mid Infrared absorption spectroscopy:

Mid Infrared spectrum has a wavelength in the range of 2500-10,000nm. This wavelength is longer than NIR. It results in less scattering and more absorption. The penetration length of MIR light is up to 100 μ m in human skin. To overcome this limited light penetration problem because of the large absorption coefficient, a method called attenuated total reflection (ATR) is used. In this method, a flexible hollow infrared optical fiber with a diamond (ATR) prism is used.

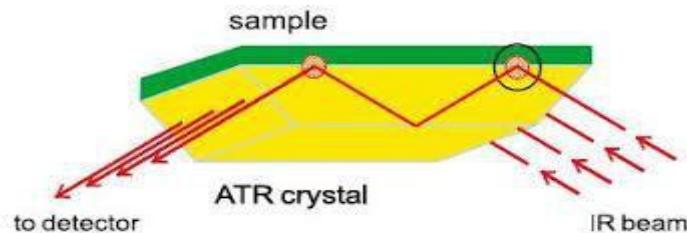


Fig.5 Mid Infrared Absorption Spectroscopy

In this method, glucose level is expected to be measured in oral mucosa with high precision because of following reasons-

- Optical fibers are non-toxic
- Mechanical and chemical stability of fiber and ATR prism
- Flexibility

Glucose concentration is then predicted with data processing technique such as partial least square regression. One should have a test on finger or oral mucosa to get best results using MIR spectroscopy.

3. Raman Spectroscopy:

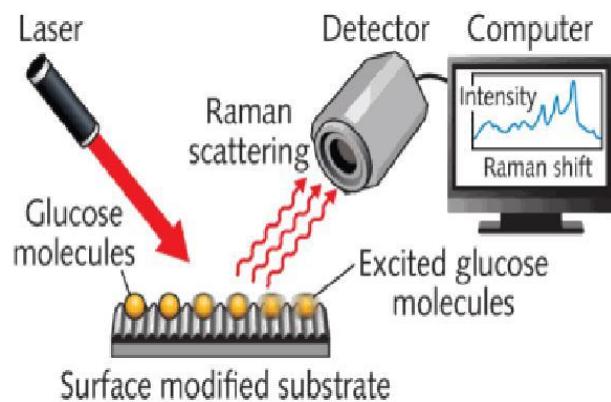


Fig.6 RAMAN Spectroscopy for glucose monitoring

The phenomenon where a very small portion of scattered light shows wavelengths dissimilar from that of the exciting laser beam is known as the Raman Effect. The detection method is based on Raman effect, i.e. the inelastic scattering of monochromatic light. Inelastic scattering means frequency of the photons is changed when it interacts with the sample/ human body. The frequency

of re-emitted photons is shifted-up or down with respect to original laser light, called Raman shift. This frequency shift gives information about molecular vibration in human fluids containing glucose. The scattered light from the human body is affected by molecular vibration. Because of this, glucose concentration in human fluids can be estimated. For Raman spectroscopy, the best site in the human body for glucose detection is Forearm.

4. Photoacoustic Spectroscopy:

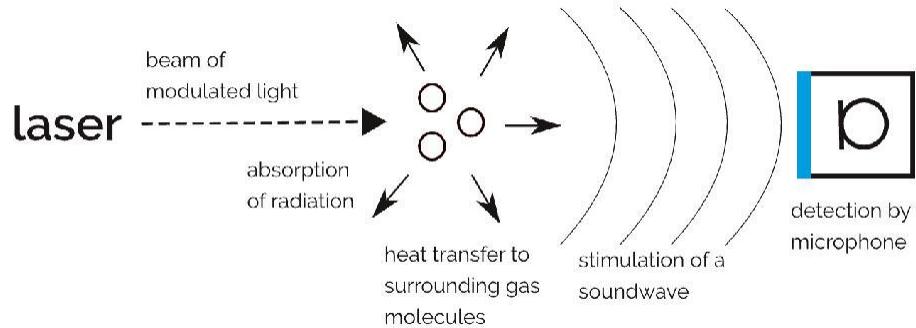


Fig.7 Concept of Photoacoustic Spectroscopy for glucose monitoring

In a photo-acoustic method, blood glucose is excited with laser pulses for very short period. light is absorbed by the PA cell in terms of its optical properties and stimulates subject's molecules. The absorbed energy is then released in the form of heat. Because of this phenomenon, volumetric expansion take place generating an acoustic wave. Piezoelectric transducer detects this acoustic wave and pass the data to controller. The data is then processed statistically to extract aa the changes in parameters. The measured acoustic wave provides information about the amount of glucose. With the amount of Glucose content, the amplitude of the sound waves changes. By measuring this change in peak-to-peak value, the glucose level is determined. To conclude, this detection method is based on conversion of optical energy to acoustic energy. To get the best results, it is recommended to have a test on forearm or finger.

5. Fluorescence:

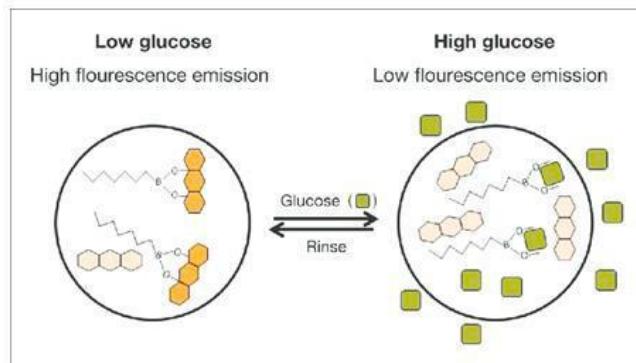


Fig.8 Fluorescence technique for glucose monitoring

When ultraviolet laser light of wavelength 380nm falls on human tissue, the fluorescence is generated by that tissue. The reflected light comprises of induced emission of light. This induced emission is due to the interactions between the glucose molecules in tissue fluid and the excitation light. The light reflected is detected by a sensor device. Depending upon the intensity of the light detected, glucose level in the blood is estimated. To estimate this glucose concentration in the sample

collected, partial least square regression statistical analysis is carried out. The flaw in this system is that the use of ultraviolet light on tissue could lead to strong scattering phenomena, in addition to fluorescence. Certain skin parameters, such as pigmentation, redness, epidermal thickness or blemishes can affect the result as it will change the fluorescence. Fluorescence based contact lenses have been developed for the detection of glucose concentration in tears. These disposable lenses are easy to use and are portable. With the change in concentration of the glucose, the colour of contact lenses also varies. These hydro-gel based soft lenses are safe to be used daily by diabetic patients.

6. Metabolic heat conformation:

The direct influence of glucose concentration with body temperature is already proved in 2010. The factors like metabolic heat, oxygen supply and concentration of glucose affect the homeostatic circadian rhythm of human body. Hence, glucose concentration can be measured by following the conceptual equation.

Glucose concentration = F (heat generated, blood flow, Hb, HbO₂)

Where Hb= hemoglobin and HbO₂= oxygenated haemoglobin

A thermopile detector inside the sensor is used to measure radiation temperature of the finger. While the blood flow rate is estimated by measuring temperature difference between thermistors during contact of finger with the sensor. The next step is to measure concentration of Hb and HbO₂ using diffuse reflectance spectroscopy. The glucose concentration is estimated by applying stepwise regressions and a calibration function is performed.

7. Bio-impedance Spectroscopy:

Bioelectrical impedance analysis has been used as a non-invasive technique for glucose monitoring. The ratio of an injecting current to a resulting measured voltage is calculated which will give the change in impedance. This impedance spectrum is used to estimate electrical properties of samples by using an equivalent electrical model of the material under study. The first study of non-invasive continuous glucose monitoring system involving impedance spectroscopy was published by Cardiff's group in 2003. Based on this theory, Pendragon has developed a wrist glucose monitor called Pendra. This device collects information of a LC resonance circuit in the range of 1 MHz to 200MHz, with the skin working as dielectric from the capacitor. One limitation of this research is that it requires an equilibration process, where the patient must rest for 60 min before starting measurement.

8. Reverse iontophoresis:

By applying a low-level electrical current, glucose can be extracted through the skin by electro-osmotic flow. 'Reverse iontophoresis' is a term used to describe this action. Reverse iontophoresis is sometimes labelled as a "minimally invasive" technology as it needs the access to a small amount of interstitial fluid underlying the skin. To check that, the circulation of a low-level electric current from anode to cathode located on skin surface is calculated. The primary current is produced by migration of sodium ions. It leads to cause a convective flow (electro-osmotic flow) of the interstitial fluid (ISF), which along with carries glucose molecules towards the cathode with it. The glucose sensor is placed at the cathode side to measure glucose level directly by enzymatic approach i.e., oxidization by an enzyme, such as glucose oxidase.

9. Ultrasound:

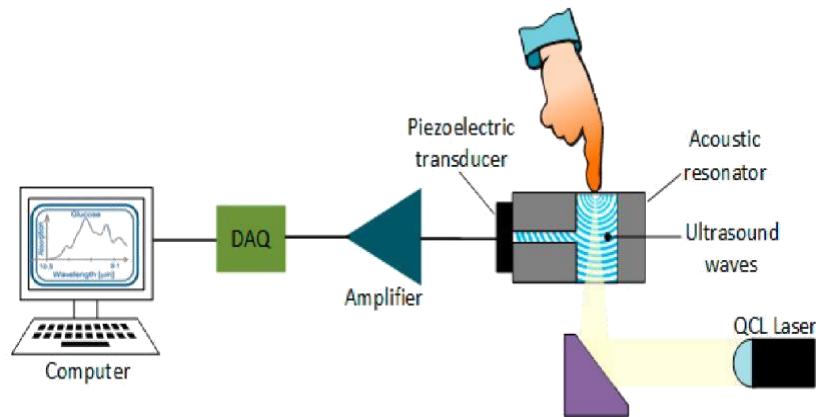


Fig.9 Ultrasound method for glucose monitoring

This technology measures the propagation time of ultrasound waves through the subject. The higher the glucose concentration, the faster the ultrasonic wave propagates through the media, hence reducing the time of propagation. The fluid or tissue has a certain degree of compressibility depending on the strength of intermolecular bonding forces and the density of the medium with the help of which the acoustic velocity of low-frequency waves through the media is estimated. Because of the change in linear impedance, the changes of the glucose concentration in the extracellular fluid affect density and adiabatic compressibility.

3. CONCLUSION

A lot of research has been done over the years to develop non-invasive techniques for monitoring of glucose. Our paper provides a comparative study of different techniques used till the date, and the principles of their application. The purpose of this paper is to suggest various non-invasive methods for measuring blood glucose concentration and such methods would be useful even for people without illness, addressing preventive care.

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Phytochemical Analysis and Antibacterial Activity of *Piper Nigrum*, *Elettaria Cardamomum*, *Artabotrys Hexapetalus* and *Clerodendrum Inerme*

Dr. J. Anbumalarmathi

Department of Biotechnology,
Stella Maris College (Autonomous),
Chennai -600 086

K. Mercy Madhumitha

Department of Biotechnology,
Stella Maris College (Autonomous),
Chennai -600 086

ABSTRACT

Medicinal plants are discovered and utilized in traditional medicine practices since prehistoric times. The aim of the study was to investigate the phytochemical compounds present in the leaf and to screen the antibacterial activity of *Piper nigrum*, *Elettaria cardamomum*, *Artabotrys hexapetalus* and *Clerodendrum inerme* against Gram negative and Gram-positive bacteria such as *Salmonella typhi*, *Klebsiella*, *E. coli*, *Vibrio parahaemolyticus*, *Staphylococcus epidermidis*, *Bacillus subtilis*, *Bacillus cereus*, *Enterococcus*, *Micrococcus* and *Pseudomonas*. The phytochemical analysis of ethanol and showed that carbohydrates and tannins were present in all the extracts of *P. nigrum*, *E. cardamomum*, *A. hexapetalus* and *C. inerme*. Steroids were present in all the extracts of *P. nigrum* and *E. cardamomum*. Flavonoids, terpenoids and phenol were present in the extracts of *A. hexapetalus* and *C. inerme*. Resin was present in both the ethanol and methanol extracts of *A. hexapetalus*. The methanol leaf extract of *A. hexapetalus* showed maximum zone of inhibition of *E. coli* (20mm). *Bacillus subtilis* showed minimum inhibition (11mm) in the ethanol leaf extract of the same. The growth of *V. parahaemolyticus* was inhibited by the methanol extract of *C. inerme* which showed a zone of inhibition of 17mm. Only the methanol leaf extract of *C. inerme* showed a zone of inhibition for *Staphylococcus epidermidis*. The methanol extracts of *P. nigrum* showed higher zone of inhibition against *E. coli* (10mm) and *S. aureus* (11mm). The methanol extract of *E. cardamomum* showed maximum zone of inhibition against *S. typhi* (13mm). The lowest zone of inhibition was shown by the ethanol extract of *P. nigrum* against *E. coli* (3mm).

Keywords: *Piper nigrum*, *Elettaria cardamomum*, *Clerodendrum inerme*, *Artabotrys hexapetalus*, isoflavones, terpinol.

1. INTRODUCTION

Nature has been a source of medicinal agents for thousands of years and an impressive number of modern drugs have been isolated from natural resources, many of these isolations were based on the uses of the agents in traditional medicine (Magesh and Sathish 2008)

Piper nigrum L. (Black pepper) belongs to the family *Piperaceae*, which is widely used as a spice because of its strong flavor hence it is called “the king of spices” and mainly used as medicinal ingredient in most of the traditional remedies (Damanhouri and Ahmad, 2014) and (Zahin *et al.*, 2021). It is cultivated as white and black pepper according to the harvest time. The dried immature

and fully developed fruit is known as black pepper, whereas mature fruit is known as white pepper (Lee *et al.*, 2020)

The essential oil of black pepper shows wide range of medicinal application such as antioxidant, anti-fungal, anti-amoebic, anti-asthmatic, anti-diabetic and immunomodulatory activities. Even white pepper as its own medicinal applications such as preservative, insecticide, anti-bacterial, anti-fungal and anti-protozoal. (Lee *et al.*, 2020)

Especially both black and white peppers contain a common bioactive compound “piperine” a pungent alkaloid, which is considered to possess many pharmacological actions. This alkaloid has various pharmacological activities such as antihypertensive, anti-tumor, anti-platelet, anti-oxidant, anti-asthmatics, anti-inflammatory, anti-spasmodic, anti-depressants, anti-convulsant, anti-thyroids, anti-bacterial, anti-fungal, analgesic, hepato-protective, insecticidal and larvicidal activities (Damanhouri and Ahmad, 2014).

Elettaria cardamomum (cardamom) belongs to the family *Zingiberaceae*, most commonly called as “elaichi” and well known as the “Queen of spices”, which has a pleasant aroma and strong flavor. It is mainly used in the dietary habits by millions of people around the world and also has immense pharmacological properties which includes sedative, anti-hypertensive, anti-bacterial, anti-microbial, anti-oxidant, anti-inflammatory, anti-alzheimer, anti-cancer, analgesic, anti-convulsant, anti-hypercholesterolemic, anti-spasmodic and many more activities (Sharma *et al.*, 2011).

E. cardamomum traditionally used to treat asthma, teeth and gum infections, cold, cough, bladderinfection, constipation, stomach ache, kidney disorder and improves the eyesight, which is also acts as an Ayurvedic remedy in case of urinary complaints, digestive problems and many other human ailments. (Kumar and Kumari, 2021)

The bioactive compounds such as proteins, lipids, carbohydrates, minerals, terpenoids, carotenoids, flavonoids and essential oils are used as flavoring agents. It also helps to get rid from addiction of cigarettes. Even the chain smoker when he takes couple of cardamom seeds initially helps him to lower the amount he takes daily (Peter, 2001).

Artobotrys hexapetalus (Manoranjidam) belongs to the family *Annonaceae*, one of the well knownimportant medicinal plant is distributed all over the world including India, Sri Lanka and South China. The leaves of this plant are mainly used against cholera and as anti-fungal. Flower are used in perfume industry , used for preparing tea like beverage and most importantly the essential oil which is yield from flowers has anti-fungal activity. Fruits has cardiac depressant activity (Sowjanya *et al.*, 2013 and Puri, 2020).

The phytochemical analysis revealed the presence of terpenoids, anthraquinones, alkaloids, butyrolactones, neolignans, phenolic compounds, flavonoids, leucoanthocyanins etc., which

contribute the therapeutic properties are isomericanol, artabotricinol, americanin, artabotriol, glucoluteolin and taxxifolin. Its also as a pharmacological activities such as anti- microbial, anti-leishmanial, anti-oxidant, anti-fungal, anti-fertility and anthelmintic properties (Puri, 2020).

Clerodendrum inerme belongs to the family *Verbenaceae* commonly called as Sangam or peechanguin Tamil and wild jasmine in English. It is an important medicinal plant used to treat various ailments in humans. The phytochemical analysis of leaf revealed the presences of various constituents such as alkaloids, carbohydrates, glycosides, anthraquinone glycosides, saponins, steroids, tannins, phenolic compounds and proteins (Bhushan *et al.*, 2015)

The pharmacological activities which include anti-inflammatory, analgesic, anti-pyretic, neural and smooth muscle effect, anti-cancer, anti-microbial, anti-diabetic, anti-oxidant, anti-parasitic, insecticidal, anti-allergic are reported in *C. inerme*. It is also traditional used to treat uterine stimulant, as a pest control agent, antiseptic, to arrest bleeding. Hepatitis, to treat asthma, ringworm, stomach pains and in the treatment of scrofulous and venereal infections. It is also used as an antidote for poisoning from crabs and fish. The roots are boiled in hot oil and used to treat aheumatic affections (Al-snafi, 2016).

2. Materials and Methods

Collection of Plant material

The fresh leaves of Pepper (*Piper nigrum*), Cardamom (*Eletteria cardamomum*) were collected from Kumily, Idukki district, Kerala, India. *Cleodendrum inerme* were collected from Chennai, TamilNadu and *Artabotrys hexapetalus* were collected from Botanical Garden of Stella Maris College (Autonomous). The plant materials were rinsed with distilled water and shade dried in room temperature.

Preparation of plant extract

The shade dried, cut into fine pieces and powdered using mechanical blender and subjected for successive extraction using ethanol and methanol separately using Soxhlet apparatus.

Collection of the test organism

Stock cultures of Gram negative organism (*Escherichia coli*, *Salmonella typhi*, *pseudomonas*, *Vibrioparahaemolyticus*, *Klebsiella*) and Gram- positive organism (*Staphylococcus aureus*, *Micrococcus*, *Bacillus subtilis*, *B.cereus*, *Enterococcus*) was collected from University of Madras, Department of Biotechnology, Guindy campus, Chennai.

Phytochemical analysis of leaf extracts

The Pepper, Cardamom, *Cleodendrum inerme* and *Artabotrys hexapetalus* extracts obtained from Ethanol, Methanol and Ethyl acetate were subjected to preliminary qualitative tests for the presence of Carbohydrates, Proteins, Steroids, Flavonoids, Tannins, Alkaloids and Quinones. **Test for Flavonoids** (Umesh Kumare *et al.*, 2010)

To 2ml of extract was added 1ml 2N NaOH. Appearance of yellow color indicates the presence of flavonoids.

Test for Alkaloids (Culki, 1994)

Mayer's Test

To 2ml extract was added 2ml of concentrated hydrochloric acid and a few drops of Mayer's reagent. A green or white precipitate indicating the presence of alkaloids.

To the powder few drops of Hg_2Cl_2 was added. Black and blue color indicates the presence of alkaloids.

Test for Tannins (Culki, 1994)

To 1ml of extract was added 2ml 5% ferric chloride. A dark blue or green black color indicates the presence of tannins.

To the powder few drops of concentrated nitric acid was added. An orange yellow or orange brown color indicates the presence of tannins.

Test for Saponins (Evans 1989, Harbrone 1998)

- a) **Foam Test-** The crude extract is mixed with 5ml of distilled water and shaken vigorously. The formation of stable foam is taken as positive results for saponins.
- b) **Froth Test-** 2g of the powdered sample is boiled with 10ml of distilled water and then filtered and mixed with 5ml of distilled water and then observed after adding few drops of olive oil & shaken vigorously.

Test for Terpenoids (Evans 1989, Harbrone 1998)

To 2ml of each is fixed with 5ml of chloroform and a few drops of concentrated sulphuric acid is carefully added to form a layer. A reddish-brown coloration formed in the interface shows positive results for the presence of terpenoids.

Test for Glycosides (Umeshet al., 2010)

Keller-Killani Test: 1ml of glacial acetic acid comprising remnants of ferric chloride and 1ml of concentrated sulphuric acid was added to the extracts carefully. A reddish-brown color is made at the intersection of 2 layers and the upper layer goes bluish green in presence of glycosides.

Test for Steroids (Umeshet al., 2010)

- a) **Salkowski reaction-** 2ml of extract was added to 2ml of chloroform and 2ml of concentrated sulphuric acid and shaken well. Chloroform layer shows greenish yellow

fluorescence. **Test for Quinones (Umeshet al., 2010)**

1ml of concentrated sulphuric acid was added to 1ml of extract. A red color was formed. **Test for Resins (Evans 1989, Harbrone 1998)**

Acetone- water test: extracts has to be treated with acetone. Little water was added and shaken. Look of turbidity shows the presence of resins.

Test for carbohydrates (Brain and Turner, 1975)

Molisch test

To about 2ml extracts few drops of α -naphtha (20% in ethyl alcohol) was added. Then about 1ml of conc. sulphuric acid was added alongside of the test tube- reddish violet ring at the junction of the 2 layers are appeared in the presence of carbohydrates.

Reduction of Fehling's Solution

Fehling solution 10ml was add up to the concentrated extracts heated on a steam bath. Brick-red precipitates showed the presence of carbohydrate.

Test for Proteins (Umeshet *et al.*, 2010)

- a) **Biuret test-** To 3ml of extract, 4% NaOH and few drops of 1% copper sulphate solution was added. violet or pink color appears.
- b) **Ninhydrin test-** To 1ml of extract was added 1% reagent was added and heated on a steambath. Violet color indicates the presence of amino acids.
- c) To the powder, few drops of AgNO_3 was added. Precipitate formation signals the presence of proteins.

Determination of Antibacterial Activity of the extracts (Bauer *et al.*, 1966)

In vitro antibacterial activities of the extracts were studied against Gram negative and Gram-positive bacteria by the agar well diffusion method. The extracts were dissolved in 5% (v/v) DMSO to a final concentration of 15 mg. DMSO was taken as the control.

Muller Hinton agar was utilized as the bacteriological medium. Suspension of microorganisms were made in Nutrient broth and adjusted to 0.5 McFarland standards ($1 \times 10^5 \text{ cfu/ml}$). *Each labelled medium plate was uniformly spread with 100 μl of test organism. A sterile cork borer of 5 mm diameter was used to make wells on the medium. Various concentrations (50 mg, 100 mg, 200 mg, 500 mg) of the extracts were added into each well and appropriately labelled. The inoculated plates were kept at 4°C for 20 minutes to allow the extracts to diffuse into the agar. The plates were incubated at 37°C for 24 hours. Antibacterial activity was revealed by measuring the diameter of zones of inhibition (mm) produced after incubation.*

3. RESULTS

Phytochemical Analysis:

The analysis showed that carbohydrates and tannins were present in all the extracts of *Piper nigrum*, *Eleteria Cardamomum*, *Artrabotrys hexapetalus* and *Cleodendrum Inerme*. Steroids was present in all the extracts of *P. nigrum* and *E. cardamomum*. Flavonoids, terpenoids and phenol were present in

the extracts of *A. hexapetalus* and *C. inerme*. Resin was present in both the ethanol and methanol extracts of *A. hexapetalus*. (Table – 1)

TABLE – 1:

	<i>P. nigrum</i>		<i>E. cardamomum</i>		<i>A. hexapetalus</i>		<i>C. inerme</i>	
Extract	Ethanol	Methanol	Ethanol	Methanol	Ethanol	Methanol	Ethanol	Methanol
Carbohydrate	+	+	+	+	+	+	+	+
Proteins	-	-	-	-	ND	ND	ND	ND
Steroids	+	+	+	+	ND	ND	ND	ND
Glycosides	+	-	+	-	-	+	+	+
Tannins	+	+	+	+	+	+	+	+
Alkaloids	+	+	-	+	-	-	-	-
Flavonoids	-	-	-	-	+	+	+	+
Quinone	-	-	-	-	ND	ND	ND	ND
Terpenoids	ND	ND	ND	ND	+	+	+	+
Saponins	ND	ND	ND	ND	-	-	-	-
Phenol	ND	ND	ND	ND	+	+	+	+
Resin	ND	ND	ND	ND	+	+	-	-

NOTE + is positive; - is negative; ND for tests not done

Antibacterial activity of leaf extracts of *Artobotrys hexapetalus* and *Cleodendrum inerme* against organisms:

The methanol extract of *A. hexapetalus* showed maximum zone of inhibition of *E. coli* (20mm). *Bacillus subtilis* showed minimum inhibition (11mm) in the ethanol extract of the same. The growth of *V. parahaemolyticus* was inhibited by the methanol extract of *C. inerme* which showed a zone of inhibition of 17mm. Only the methanol extract of *C. inerme* showed a zone of inhibition for *Staphylococcus epidermidis* (11mm). (Table–2)

Table – 2:

Microorganisms	Zone of Inhibition (in mm)							
	<i>Artobotrys hexapetalus</i>				<i>Cleodendrum inerme</i>			
	Ethanol		Methanol		Ethanol		Methanol	
	50µg	100µg	50µg	100µg	50µg	100µg	50µg	100µg
<i>Salmonella typhi</i>	13	23	17	20	-	-	-	-
<i>Klebsiella</i>	20	23	19	20	-	-	-	-

<i>E. coli</i>	17	24	22	28	-	-	-	-
<i>Vibrio parahaemolyticus</i>	16	20	19	23	11	12	15	17
<i>Staphylococcus epidermidis</i>	13	18	17	21	-	-	-	11
<i>Bacillus subtilis</i>	12	11	22	24	-	-	-	-
<i>Bacillus cereus</i>	18	19	16	19	-	-	-	-
<i>Enterococcus</i>	18	24	15	18	-	-	-	-
<i>Micrococcus</i>	16	21	18	20	12	15	-	-
<i>Pseudomonas</i>	21	28	18	24	12	14	11	13

NOTE: ‘-’ indicates no zone of inhibition

Antibacterial activity of Pepper and Cardamomum extracts against standard bacterial strains:

The methanol extracts of *P. nigrum* showed higher zone of inhibition against *E. coli*(10mm) and *S.aureus* (11mm). The methanol extract of *E. cardamomum* showed maximum zone of inhibition against *S. typhi*(13mm). The lowest zone of inhibition was showed by the ethanol extract of *P.nigrum* against *E. coli*(3mm). (Table-3)

TABLE – 3:

EXTRACTS	Zone of inhibition (in mm)							
	<i>P. nigrum</i>				<i>E. cardamomum</i>			
	Ethanol		Methanol		Ethanol		Methanol	
Strains	50 µg	100 µg	50µg	100 µg	50 µg	100 µg	50 µg	100 µg
<i>E. coli</i>	6	3	10	10	-	3	5	7
<i>S. aureus</i>	10	13	12	11	-	4	4	7
<i>S. typhi</i>	5	11	9	13	6	11	9	13

NOTE: ‘-’ indicates no zone of inhibition.

4. DISCUSSION & CONCLUSION:

The results show that the antibacterial activity of methanol and ethanol extracts of leaves of *Artobotrys hexapetalus* and *Cleodendrum inerme*. Some antibiotic resistant strains were tested for antibacterial activity of *Piper nigrum* and *Eletteria cardamomum*.

The methanol extracts of *A. hexapetalus* leaves showed a significant zone of inhibition against gram positive and gram negative bacteria. The antibacterial agar diffusion method was observed in the

extract of pepper. Cardamomum produced an antibacterial activity against both gram positive and gram negative bacteria (Yustc and Fung 2004). The extract of carbohydrate and protein was present in both ethanol and methanol extract of *P. nigrum*, *E. cardamomum*, *A. hexapetalus* and *C. inerme*. No tests were done for the presence of terpenoids, saponins, phenol and resins for the *A. hexapetalus* and *C. inerme* extracts.

The methanolic extracts of the leaves of *A. hexapetalus* showed a maximum zone of inhibition in *E.coli*. *Bacillus subtilis* was inhibited maximum by the ethanolic extracts of the same. It showed the same range of effect against both gram positive and gram negative organisms. The methanolic extracts of *C. inerme* were found to be effective against *Staphylococcus epidermidis* (20mm). *Vibrio haemolyticus* showed high susceptibility to the methanolic extract of *C. inerme*. *Bacillus subtilis*, *Bacillus cereus*, *Salmonella typhi*, *Klebsiella*, *E. coli*, *Vibrio haemolyticus*, *Staphylococcus epidermidis* and *Pseudomonas* were seen to be very resistant against *Cleodendrum inerme* at 50 μ g/ml of ethanolic extract. The methanolic leaf extracts exhibited highest zone of inhibition against *S. aureus* and *S. typhi* (Chehar *et al.*, 2010). The study showed the antibacterial activity of *E. cardamomum* against the organism *Klebsiella pneumonia* (Fang *et al.*, 1992). The methanolic leaf extracts exhibited highest zone of inhibition against *S. aureus*.

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Breast Cancer Risk Prediction System Using Machine Learning Model

Ms. Mithila Chavan

Assistant Professor

Department of Information Technology,
VSIT, Wadala (East), Mumbai 400037
Email: mithila.chavan@vsit.edu.in
9821073039

Dr. Amita Jain

Assistant Professor

Department of Information Technology,
VSIT, Wadala (East), Mumbai 400037
Email: amita.jain@vsit.edu.in
9425026143

ABSTRACT

Breast cancer is the leading cause of cancer death in women, accounting for 16 percent of all cancer deaths worldwide. Owing to recent population growth in medical science, early detection of disease has become a critical issue. The risk of death from breast cancer is increasing rapidly as the world's population grows. Early diagnostics meaningfully increases the chances of correct treatment and survival, but this process is monotonous and often leads to a disagreement between pathologists. One of the best ways to fight cancer is timely detection, when it is still confined and can be fully removed surgically or treated pharmacologically. Computer-aided diagnosis systems presented the potential for improving diagnostic accuracy.

Keywords—breast cancer dataset, machine learning, Logistic Regression, prediction, IBM cloud

1. INTRODUCTION

Cancer is defined as the uncontrollable division of aberrant cells that destroy normal human tissue. Lung cancer, kidney cancer, breast cancer, bladder cancer, colorectal cancer, and many other types of cancer exist. Breast cancer is one of the most extensively prevalent diseases on the planet. Breast cancer is defined as the abnormal growth of breast cells in women, although it can also affect men. It is the most common malignancy among women, accounting for nearly 1 in 3 cancers diagnosed among women in the United States, and it is the second leading cause of cancer death among women. Breast cancer is caused by a combination of factors. Table 1 represents Several risk factors for breast cancer.

Non-modifiable risk factors	Modifiable risk factors	Environmental factors
1. Age 2. Sex 3. Genetic factors (5-7%) 4. Family history of breast cancer 5. History of previous	1. Menstrual 2. Reproductive factors 3. Radiation exposure 4. Hormone replacement therapy 5. Alcohol 6. High-fat diet	1. Organochlorine exposure, 2. Electromagnetic field 3. Smoking

breast cancer 6. Proliferative breast disease		
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Breast Cancer occurs because of abnormal growth of cells in the breast tissue, commonly referred to as a Tumor. There are two types of tumors: benign and malignant. Benign tumors are non-cancerous and do not infiltrate or spread to other areas of the body, whereas malignant tumors are cancerous and can invade and kill neighboring tissue that spread to other parts of the body. When a malignant tumor (lump of tissue) develops in the breast, it is called breast cancer.

In this article, benign is represented by B, while malignant is represented by M. Doctors have a difficult and time-consuming process when diagnosing breast cancer in a patient at an early stage. However, by utilizing artificial intelligence, machine learning can assist in the effective and accurate prediction and detection of breast cancer. Machine learning allows a system to learn on its own and improve as it gains experience.

For prediction and accuracy computation, it employs a variety of algorithms. Breast cancer can be predicted using effective models such as logistic regression, SVC, KNN, decision tree, and random forest, which provide excellent accuracy. The highly effective model is evaluated using a 10-fold cross-validation test. The following parameters are used to validate the model: accuracy, RMSE Error, sensitivity, specificity, F-Measure, ROC Curve Area, and Kappa statistic, as well as the time it took to develop the model.

Author	Year of publication	Classifiers	Accuracy achieved
Aindrila Bhattacherjee, Payel Roy, Sourav Roy, Noreen Kausar, Sneha Paul, Nilanjan Dey	2016	Back Propagation Neural Network	99.27%
Hiba Asri, Hajar Mousanni, Hassan Al Moatassime, Thomas Noel	2016	Support Vector Machine	97.13%
Dada Emmanuel Gbenga, Ngene Christopher, Daramola Comfort Yetunde	2017	Support Vector Machine	97.07%
Vikas Chaurasia, Saurabh Pal, BB Tiwari	2018	Naive Bayes	97.36%

Jabeen Sultana, Abdul Khader Jilani	2018	Logistic Regression	97.18%
Farahnaz Sadough, Zahra Kazemy, Farahnaz Hamedan, Leila Owji, Meysam Rahmanikatigari, Tahere Talebi Azadboni	2018	Support Vector Machine	Ultrasound- 95.85%, Mammography- 93.069%, Thermography- 100%
Ricvan Dana Nindra, Teguh Aryandono, Lazuardi, Iwan Dwiprahasto	2018	Support Vector Machine	99.51%
R. Cthihrakkannan, P. Kavitha, T. Mangayakarasi, R. Karthikeyan	2019	Deep Neural Network	96%
David A. Omundiagbe, Shanmugam Veeramani, Amandeep S. Sidhu [9]	2019	Support Vector Machine	98.82%
Anji Reddy Vaka, Badal Soni, Sudheer Reddy K. [10]	2020	Deep Neural Network with support value	97.21%

TABLE 2: Summary of Literature survey

2. METHODOLOGY

A. Dataset and Pre-processing

The breast cancer dataset has been retrieved from UCI machine learning. There are 569 occurrences in this dataset, where the cases are moreover benign or malignant. For such cases, 357 (%) are benign, and 212 (%) are malignant. The class in the dataset is partitioned as B or M, wherever B corresponds to the benign case, and M corresponds to the malignant case.

The attributes entail in the dataset which is in the figure below eliminating sample code number and class level. The benign cases are identified as a positive class, and the malignant cases are recognized as a negative class in our investigate.

A	B	C
1 id	area_se	
2 diagnosis	smoothness_se	
3 radius_mean	compactness_se	
4 texture_mean	concavity_se	
5 perimeter_mean	concave points_se	
6 area_mean	symmetry_se	
7 smoothness_mean	fractal_dimension_se	
8 compactness_mean	radius_worst	
9 concavity_mean	texture_worst	
10 concave points_mean	perimeter_worst	
11 symmetry_mean	area_worst	
12 fractal_dimension_mean	smoothness_worst	
13 radius_se	compactness_worst	
14 texture_se	concavity_worst	
15 perimeter_se	concave points_worst	
16 symmetry_worst	fractal_dimension_worst	
17		

Figure1: Attributes of the dataset

Data Preprocessing:

Data preprocessing is used to complement absent values, identify, or remove outliers, and solve self-contradiction. There are 16 absent values of traits present in the dataset. Furthermore, the dataset is working on random selection to confirm the proper circulation of the data. Training and Testing Phase The training phase extracts the structures from the dataset and the testing phase is used to calculate how the appropriate model performs for prediction. The dataset is divided into two sections. These are the training and testing phase.

K fold cross-validation portrays that a single fold is utilized for testing and $k - 1$ folds are being used training circularly. Cross-validation is used for escaping of overfitting.

B. Machine Intelligence Libraries:

LGBM classifier: Light Gradient Boosted Machine is a real and efficient way of gradient boosting algorithm. LightGBM extends the gradient boosting algorithm by adding a type of reflex feature selection as well as concentrating on boosting samples with bigger gradients. This can result in a dramatic speedup of training and improved predictive presentation. Light GBM grows tree vertically while other algorithm produces trees horizontally meaning that Light GBM grows tree leaf-wise while the other algorithm grows level-wise. It will select the leaf with max delta loss to grow. When growing the same leaf, Leaf-wise algorithm can reduce more loss than a level-wise algorithm.

Random Forest Classifier: It is a supervised learning growth that consists of many individual decision trees that operate. Each individual tree in the random forest splitting out class prediction and the class with the most votes become our model's prediction. One big advantage of random forest is that it can be used for both classification and regression problems, which form many current machine

learning systems.

Hyperparameter optimization: Hyperparameters have dissimilar parameter values that are used to control the learning process and have a substantial effect on the presentation of machine learning models. An example of hyperparameters in the Random Forest algorithm is the number of estimators (n_estimators), maximum depth (max_depth), and principle. These factors are tunable and can have a direct impact on how well a model trains. So, then hyperparameter optimization is the whole process of finding the right mix of hyperparameter values to achieve the highest performance on the data in a reasonable amount of time.

Feature Engineering:

Feature engineering is about making new input features from your existing ones. In general, you can presume of data cleaning as a process of subtraction and feature engineering as an extra process. This is often one of the most valued tasks a data scientist can do to raise model performance, for several reasons:

1. You can separate and highlight key information, which improves your algorithms "focus" on what's important.
2. You can bring into your own domain expertise.
3. Most important thing is, once you understand the "vocabulary" of feature engineering, you can bring in someone else's domain expertise!

Node-Red:

Node-RED is a visual tool for connecting the Internet of Things. It used to connect devices, data and API's. It can also be used for other kinds of applications to quickly assemble the streams of services. Node-RED is accessible as open source and has been applied by the IBM Emerging Technologies for the association. Node-RED provides a browser-based flow editor that makes it easy to wire together flows using the wide spectrum of nodes in the palette. Flows can be then deployed to the runtime in one single-click. Whilst Node-Red is built on Node.js, JavaScript functions can be prepared within the editor using a rich text editor. A built-in collection that enables you to save useful functions, templates or flows for re-use.

C. Method used:

IBM Watson is an emerging and user-friendly tool for solving issues related to healthcare or any scope of human intent. It gives a learner free space to experiment using various artificial problem and classifiers which help to evaluate the accuracy.

Here a cloud account is used to create a service that allocates resource for conducting the experiment. Further it allows to upload the csv file which is loaded to generate the algorithm. Here the rule of training and testing must be mentioned also this is the phase which determines which classifier as well as hyperparameters to be used for giving various accuracies an algorithm can generate depending on the trials and the pipelines used.

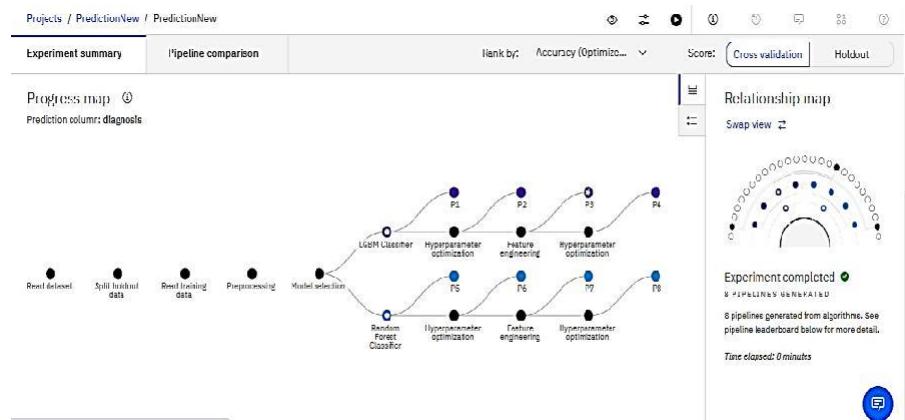


Figure2: Pipeline generation

Rank	Name	Algorithm	Accuracy (Optimized)	Enhancements	Build time
1	Pipeline 3	IGRM Classifier	0.932	HPO-1 FE HPO-2	00:00:57
2	Pipeline 4	LGJM Classifier	0.912	HPO-1 FE HPO-2	00:01:21
3	Pipeline 8	RandomForest Classifier	0.930	HPO-1 FE HPO-2	00:00:11
4	Pipeline 2	IGRM Classifier	0.928	HPO-1	00:00:24
5	Pipeline 6	RandomForest Classifier	0.926	HPO-1	00:00:20
6	Pipeline 7	RandomForest Classifier	0.926	HPO-1 FE	00:01:11
7	Pipeline 1	LGBM Classifier	0.912	None	00:00:01
8	Pipeline 5	RandomForest Classifier	0.912	None	00:00:05

Figure 3: Accuracy Summary

Every pipeline is associated with an accuracy as well as the enhancements done from one phase to another. It also delivers the time required to build the individual phase and complete algorithm. As this is concerned with algorithm further, we look for creating a interface which accepts value from the user for which NodeRed tool is utilized which creates a visual flow from data acceptance, preprocessing, optimization and output. It makes use of the javascript API key which is generated towards the allocation of the resources.

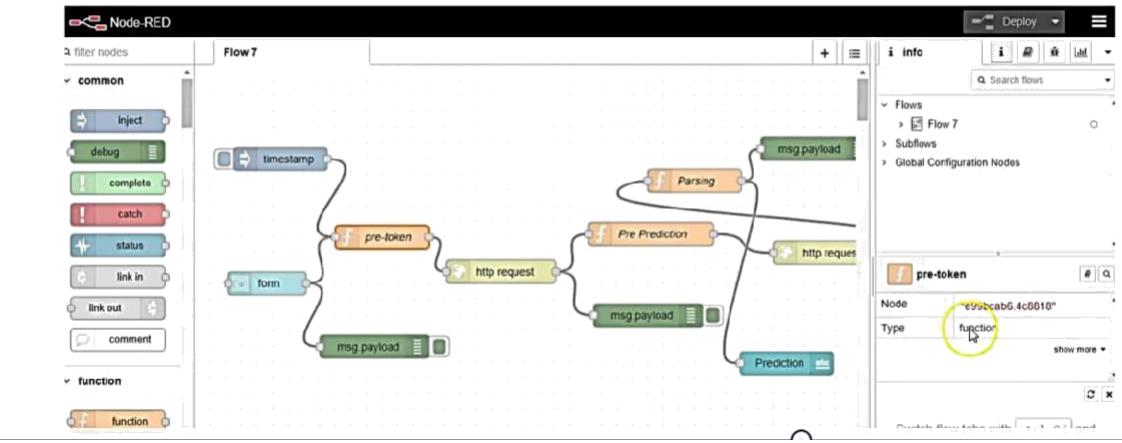


Figure 4: Node-RED interface

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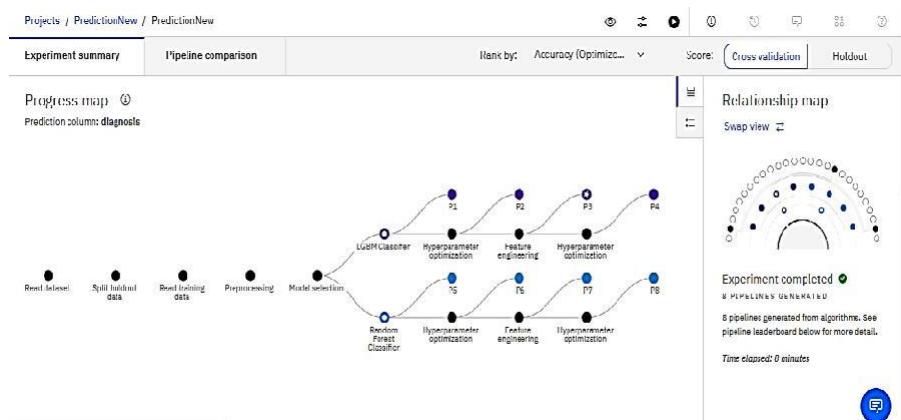


Figure2: Pipeline generation

Experiment summary						
Experiment summary		Pipeline comparison		Rank by:	Accuracy (Optimized)	Score: Cross-validation
Rank	↑	Name	Algorithm	Accuracy (Optimized)	Enhancements	Build time
★ 1		Pipeline 3	IGRM Classifier	0.932	HPO-1 FE	00:00:57
2		Pipeline 4	IGRM Classifier	0.932	HPO-1 FE HPO-2	00:01:12
3		Pipeline 8	Random Forest Classifier	0.930	HPO-1 FE HPO-2	00:00:41
4		Pipeline 2	IGRM Classifier	0.928	HPO-1	00:00:24
5		Pipeline 6	Random Forest Classifier	0.926	HPO-1	00:00:20
6		Pipeline 7	Random Forest Classifier	0.926	HPO-1 FE	00:01:11
7		Pipeline 1	LGBM Classifier	0.912	None	00:00:01
8		Pipeline 5	Random Forest Classifier	0.912	None	00:00:05

Figure 3: Accuracy Summary

Every pipeline is associated with an accuracy as well as the enhancements done from one phase to another. It also delivers the time required to build the individual phase and complete algorithm. As this is concerned with algorithm further, we look for creating an interface which accepts value from the user for which NodeRed tool is utilized which creates a visual flow from data acceptance, preprocessing, optimization and output. It makes use of the javascript API key which is generated towards the allocation of the resources.

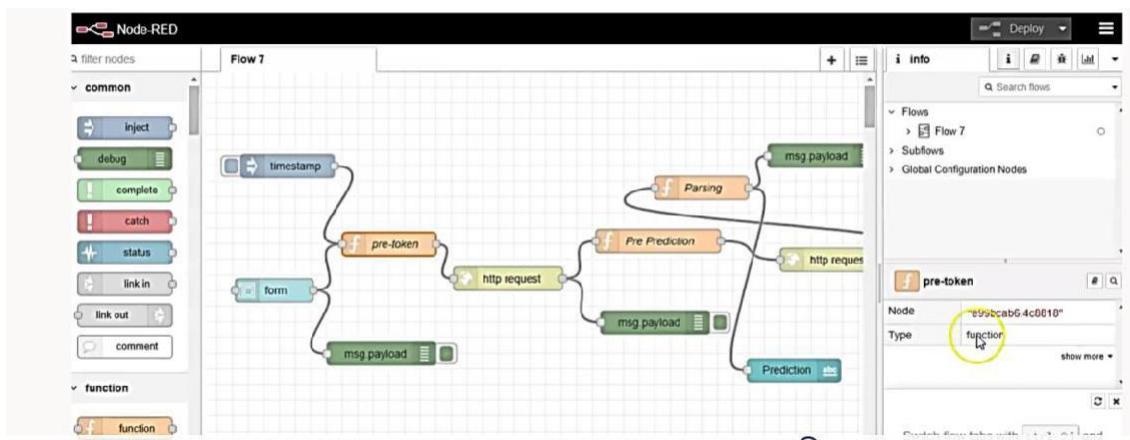


Figure 4: Node-RED interface

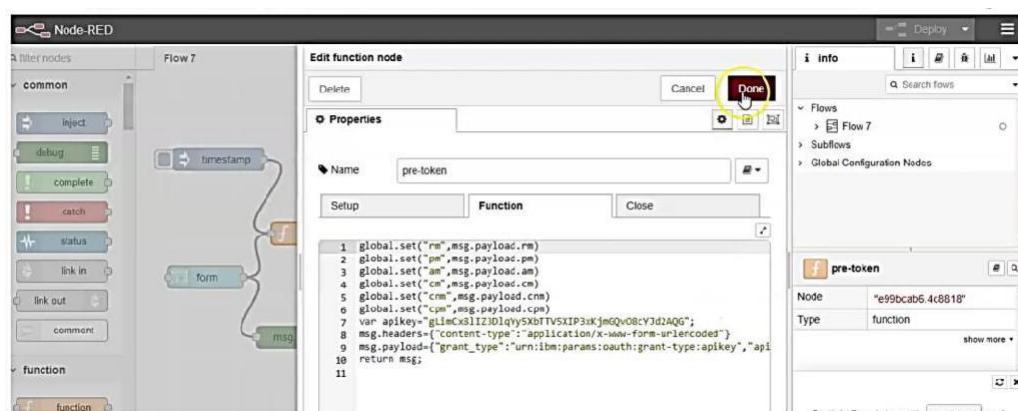


Figure 5: API Key making this a unique project.

3. RESULTS AND DISCUSSION

Breast cancer is an issue that affects many women worldwide, which has generated great interest in the scientific field to take advantage of technological developments and thus create intelligent tools or methods that allow diagnosis or prevention of successful form of said disease. Data mining is a discipline in constant development, through this many solutions must be generated for the analysis of different diseases that society suffers worldwide.

Considering the results, the levels of accuracy achieved are not the best since random forest only reached a 92.6% level of accuracy, followed LGBM with 93.2%,

The algorithm has the capability to predict the accuracy of 93%. It is also capable to show the prediction of benign and malignant cases.

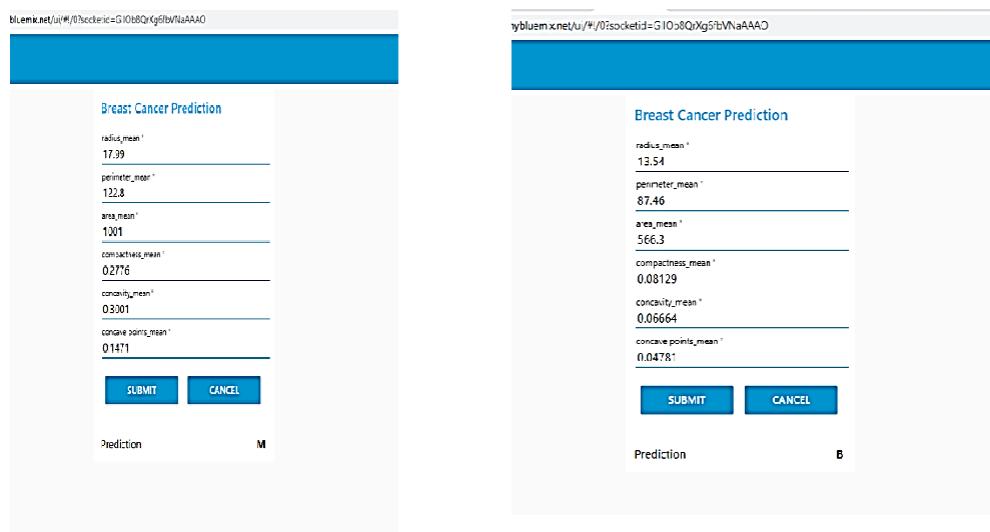


Figure 6: Results for both cases of cancer

4. CONCLUSION

Machine learning is a simple and effective technique to forecast the type of tumor a patient is suffering from, especially as the number of women diagnosed with breast cancer continues to rise. We need to forecast which cancer class a patient will be assigned by extracting hidden information from various parameters that may be used to improve overall performance using the best available technologies.

5. ACKNOWLEDGMENT

We would like to express our gratitude to IBM for providing IBM cloud and giving us the opportunity to work on it.

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Consumer Buying Behaviour Analysis Using Machine Learning Algorithm

Ms. Swapna Kadam

Research Scholar, JJTU

Email: kadamswapna23@gmail.com

Dr. Sarika Chouhan

PhD Co-Guide, JJTU

Email: sarika.chouhan@gmail.com

ABSTRACT

User-generated content, such as reviews, ratings, and comments, can be examined for enterprise use to gain more insights. The examination of this type of customer behaviour is useful in determining the customer's needs and predicting their future intentions toward the service. E-commerce companies can use this cognitive study to track the usage and attitudes associated with their items and develop appropriate marketing strategies to deliver a personalised shopping experience for their customers, thereby boosting their profit. The goal of this study is to use data-driven marketing tools like data visualisation, natural language processing, and machine learning models to better understand an organization's demographics. We also use collaborative filtering, neural networks, and sentiment analysis to create recommender systems.

Keywords: *Consumer Behaviour, Machine Learning, Online shopping, Data Mining, Sentiment Analysis.*

1. INTRODUCTION

In this modern technological age, the utilisation of E-commerce has increased. People prefer shopping online over shopping in stores. In e-commerce, data created by customers in the form of product ratings and reviews can be used to verify the product's validity and publicise it. These ratings and reviews help consumers decide whether or not to buy a particular product. Such content could include good or negative feedback from customers who have used the product before. E-commerce companies can benefit from an accurate analysis of this user-generated information to get insights and better understand their customers' intentions and needs. summarized during a model, which can then be applied to a special data set in which the category assignments are unknown. Machine Learning Algorithms can help us in creating realistic visual representations of this type of consumer behaviour. Such visual representations would aid in a more in-depth analysis of the dataset in order to comprehend and draw firm conclusions about overall consumer behaviour on the e-commerce platform. Natural Language Processing (NLP), a subfield of machine learning, is used to evaluate text and detect favourable or negative customer evaluations. Sentiment Analysis is another name for this. As a result, the data provided in the form of evaluations has the potential to influence consumer behaviour, such as their purchasing intentions. Real-time recommendations based on this intuitive analysis may be produced to create a tailored shopping experience, encouraging them to buy more and so increasing the overall profit of these businesses. The goal of this research is to look into characteristics that aid in perfectly alright organisational directions using large amounts of user-generated content.

2. OBJECTIVE

1. To understand consumer buying behavior in online shopping.

2. To improve the efficiency and analyzing the consumer behavior using Machine Learning algorithm.

3. LITERATURE REVIEW

Xiaohua Hu et. al., (2005) had proposed a data mining approach for retailing bank customer attrition analysis. In this paper, he presented a data mining approach for analysing retailing bank customer attrition.

Mahendra Pratap et. al., (2012) developed a mining of the customer behavior using web usage in e-commerce. The main purpose of this paper is to study the customer's behavior using the Web mining techniques and its application in e-commerce to mine customer behavior

Masud Karim et. al., (2013) had developed algorithms like decision tree and naive bayes for classification and generation of actionable knowledge for direct marketing. The goal of this work is to predict whether a client will subscribe a term deposit UCI data is used to train and test the performance of the algorithms.

Neeraj Sharma et. al., (2013) had proposed data mining as a tool to predict the churn behavior among Indian bank customers. The customer churn is a common measure of lost customers. By minimizing customer churn a company can maximize its profits. Companies have recognized that existing customers are most valuable assets.

R.Roselin et. al., (2014) developed customer behavior analysis for credit card proposers based on datamining techniques. This study investigates the shift of consumers towards the use of plastic money, with emphasis on credit cards.

Maheshwari. K et. al., (2017) had developed predicting customer behavior in online s4rt4ehopping using SVM classifier. In this paper, the dataset is used to analyze and categorize the customer based on their purchase behavior. The classification is performed by SVM algorithm. The inventory data set and sales data set which is available in the internet is used in this work and the performance is evaluated by using the algorithms.

4. METHODOLOGY

A. Sentiment Analysis System Architecture

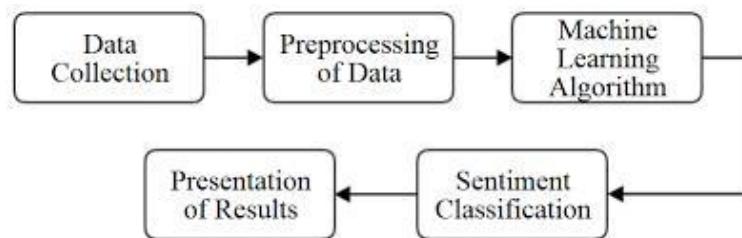


Fig. 1. The workflow of the proposed system

The user-generated content of the customer is pre-processed, the model is trained, and the results are shown on the dashboard. The above model seeks to include two things: sentiment analysis for

determining consumers' intentions and the creation of a recommendation engine based on their previous purchasing behaviour.

B. Data Pre-processing

The dataset contains Amazon product reviews which was taken from Kaggle.com. It is organised by categories such as clothes, home & kitchen, mobiles, and more. For the purposes of our research, we have chosen to work on a certain genre, namely Home & Kitchen products. Unique amazon ID, (rating, reviewer ID, summary, review, and review time are among the dataset's features. To gain a better understanding of the data, it was combined with metadata from various Amazon items, which includes information such as the product's title, description, image URL, sales rank, category, price, brand, and related products. Data was cleaned of any abnormalities and missing or duplicate values were deleted.

C. Data Visualization

All of the variables selected contribute to a better knowledge of customer behaviour through the use of various visualisation approaches. Data visualisation is used to help people understand a dataset in a more intuitive way. Statistical graphs and pie charts can provide a wealth of information. E-commerce companies might utilise these information to verify the popularity of a specific product or track customer behaviour. Some of the data visualizations performed are as shown below :

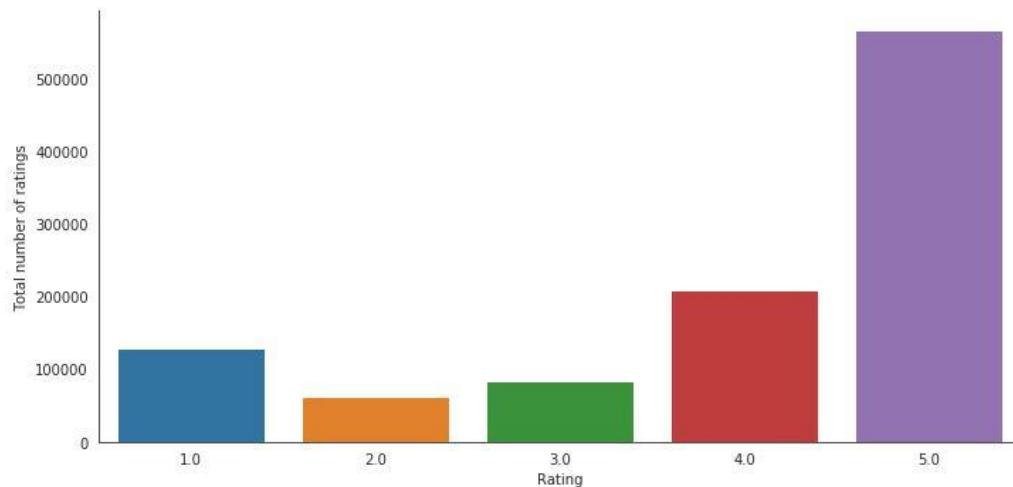


Fig. 2. Rating distribution of a Consumers

Net Promoter score was used to evaluate consumer's satisfaction and loyalty concerning amazon products. The formula for the same is given in

$$(1). NPS = (\text{Promoters} - \text{Detractors}) / \text{Total ratings} * 100$$

(1) Rating 1,2,3 are Detractors, Rating 4 is Passive and Rating 5 is Promoters.

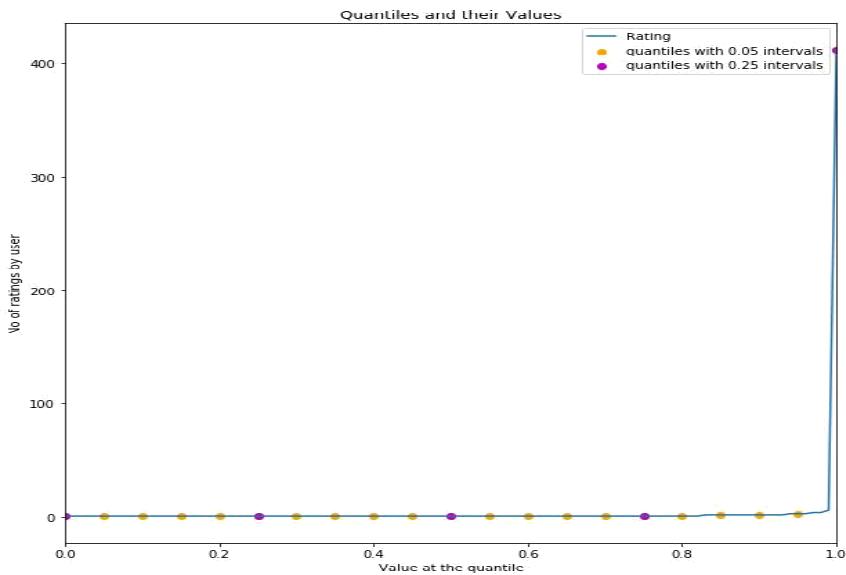


Fig 3. Analysing Rating of Consumers.

5. TECHNIQUES PROPOSED

We present two methods for evaluating customer behaviour in depth. These are the results of a sentiment analysis of all of the products. reviews to extract and comprehend customer feedback, and create recommender systems to provide a customised buying experience for the users. The review texts are first pre-processed, with all punctuation, stopwords, and stem/lemmatized phrases removed, and the cleaned text returned as a list of words. Our input variables are then vectorized. The CountVectorizer library function is used to do this. Tokenize a collection of text documents and generate a vocabulary of all the terms in that document with the CountVectorizer. This vocabulary aids in the transcription of fresh texts. The focus is on finding a pattern in the recurrence of words in that document. For analysing the sentiment score of each connected product review, we employed the categorization models below. In each of these models, 80 percent of the data is used for training and 20% is used for testing.

1) K Nearest Neighbours:

This classification model is used to locate the K closest neighbours of a given data item and determine which category it belongs to based on a distance measure. This model is a pattern recognition non-parametric supervised learning method. By presuming that comparable items are close to each other, it aids in categorising data points according to their commonalities.

2) Random Forest Classifier:

Random forests, also known as Random Decision Forests, are a type of ensemble learning method that combines numerous learning algorithms or instances of an algorithm to provide the best possible output. We create a large number of decision trees with this approach for random k points in the training set. Then, for each new data point, we generate a prediction using each of our decision trees, and output the class that is the mode of the classes or the mean forecast of the individual trees. The n estimators, or the number of trees in the forest, are set to 50 and the maximum depth of the tree is set to 90 in the random forest model.

3) Naive Bayes:

It is a supervised classification model that's based on Bayes Theorem. It assumes conditional independence between all the class variables. The Bayes theorem is given as follows:

$$P(A|B) = P(B|A) * P(A) / P(B)$$

- $P(A)$ - Prior Probability is the probability of that event occurring in general, without any other event in the picture.
- $P(B)$ - Marginal likelihood is the likelihood of any random variable added in the data to fall into a certain identified vicinity.
- $P(B|A)$ - Likelihood is the probability of event B occurring given the occurrence of event A.
- $P(A|B)$ - Posterior probability is the probability of event A occurring given the occurrence of event B.

4) The Support Vector Machine

is a classification model that is commonly used to distinguish between distinct categories using a decision boundary. The points in two classes are separated by a decision border. There can be several decision borders, but the Support Vector Machine method determines the best choice boundary. The greatest margin, which is a line equidistant from points in two different classes and having the maximum sum of the distance between the point and the line, is used to find the decision border. Support vectors are these points, and they play a big role in the algorithm's outcome.

5) Gradient Boosting Classifier

The algorithm's goal is to reduce the model's loss by employing a gradient descent-like technique to add weak learners. Weak learners are classifiers that are only minimally connected to the correct classification in this instance. It's a hypothesis-boosting algorithm of some sort. In hypothesis boosting, all of the observations used to train the algorithm are examined, and only those that were successfully classified are maintained, while the rest are eliminated. Only the observations of the set that were successfully classified are preserved, and a new weak learner is generated and tested on the set that was weakly classified. The number of boosting phases to complete is determined in our model.

6) Recurrent Neural Networks:

Recurrent neural networks are supervised learning algorithms in which the outcome of the previous phase is used as input for the following stage. RNNs are a network of nodes (neurons) that are grouped in layers. Input nodes, output nodes, and hidden nodes are all possible. All of the nodes are interconnected, which aids in the RNN model's memory, i.e. it recalls prior calculations. To do sentiment analysis on the reviews in our model, we used LSTM. LSTMs not only help to solve the problem of disappearing gradients, but they also store information in a gated cell. This cell, using gates that open and close, decides what information will be stored in the cell, read, written, or even wiped. These gates react to the signals they receive, blocking or allowing information to enter based on its intensity and importance, which they filter with their own weights. Through repeated backpropagation mistakes and gradient descent weight adjustment, the cells learn when to allow data to enter, exit, or be eliminated.

6. CONCLUSION

The purpose of this study is to assist e-commerce companies in monitoring product sales and gaining insight into client intents when purchasing a certain product. These studies assist businesses in better

understanding their clients and implementing focused marketing tactics to expand their customer base and profitability. We used several data visualisation techniques and conducted a detailed sentiment analysis on product evaluations to better understand consumer interactions with e-commerce sites. Sentiment analysis assisted us in evaluating consumer sentiments about various items, which in turn assisted us in analysing the product's market performance. With the use of natural language processing, we used five classification models for sentiment analysis of reviews and found that the Naive Bayes classifier produced the best results. Using these findings, we came to the conclusion that when a client shops on an e-commerce platform, his or her decision is influenced by a variety of factors. E-commerce businesses can identify such characteristics and take the required actions to provide better customer care and increase the lifetime value of their business.

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The Impact of Brand Extension on Parent Brand Equity: with special reference to Local Biscuits Brand in Sri Lanka

H.M.P.R. Herath

Professor

Senior Lecturer, University of Kalaniya,
Sri Lanka

Email : renukaherath@kln.ac.lk

M.T.M. Riyas

Research Student

Master of Business Management in Marketing
University of Kelaniya

Email : riyasthoufeek94@gmail.com

ABSTRACT

The purpose of this study is to explore the relationship of brand extension and parent brand equity with reference to branded biscuits products of Sri Lanka since the brand extension strategy extensively uses method in new brand development; specially in FMCG market of Sri Lanka and foreign. Further, brand commitment also is an important factor which may influence the brand extension and parent brad equity. Therefore, this variable has been used as a moderating factor for extensive analysis. The researcher used the deductive approach and followed quantitative method through survey techniques. The convenient sampling method was used to collect primary data. Additionally, the researcher used the consumer as a unit of analysis to collect the data for the study. 384 questionnaires were distributed among biscuit consumers and the primary data was collected based on researcher administrated method. Respondent rate is 100 %. Multiple regression analysis was used to test the hypotheses. The limitation of this study is primary data was collected only from Kandy and Colombo Districts among the age limit of 18 years to 45 years old biscuit consumers, targeting only 384 consumers for analysis. Since this study is limited to branded biscuit products, it lacks generalization. The researcher used the Similarity, Reputation, Perceived Risk, Innovativeness and Perceived quality as determinants of brand extension and examined the relationship with parent brand equity. The findings of this study show that all determinants of brand extension positively affect parent brand equity except innovativeness and brand extension which has a positive relationship with parent brand equity. Further, brand commitment has positive impact between the relationship of brand extension and parent brand equity. This paper has an extra value since this links theory with practice. Therefore, these findings may use to future brand development process.

Key words: *Brand, Brand extension, Brand equity, Parent brand equity, Brand commitment.*

1. Introduction

Munteanu, 2015, mentions that “brand extensions are used by companies across various industries for competitive differentiation”. According to the (Aaker, 1990) this brand extension strategy consists in using an existing brand name to launch a new product in a category considered new for the organizations.

This brand extension is referred in some literatures as brand stretching and this strategy is practiced by the marketers for well-developed brand names. The new products which are developed and

introduced by this brand extension strategy is called as a spin off. Organizations use this brand extension strategy to increase market share and leverage the brand equity of the respective brands of organizations. This strategy will increase brand awareness and profitability of the organizations. Further, this strategy is very efficient for organizations in reaching new consumers and penetrate the market. But these companies have to be more considerate when using this strategy since brand “extendibility depends on how strong consumer’s associations are to the brand’s values and goals; the brand name may lose its special positioning in the consumer’s mind through over extension” (Kotler, 2003). Further he explained this brand dilution occurs “when consumers no longer associate a brand with a specific product or similar products and start thinking less of the brand”. “The quality of the relationship between consumers and brand may have the success of these strategy” (Busacca, Bertoli, & Pelloni, 2009). It means the relationship of the new existing brand and parent brand influence the consumer buying intention or activity.

All the aforementioned scenarios investigated the impact on brand extension on parent brand by touching only the brand image or quality of brand equity. It did not focus on the whole area of the brand equity. Most of these studies are done based on mobile or electronic industries and foreign markets and did not consider the FMCG items like biscuits and could not find enough empirical studies in the Sri Lankan context. With this background, the researcher intended to find the impact on brand extension on parent brand equity: with special reference to local biscuit brands in Sri Lanka.

2.Industry Overview

Referring to the (NielsenLanka, 2017), GDP of Sri Lanka has growth slowed down compared to 2015 which are from 7.0 in 2015 2nd quarter and 5.6 in 2015 3rd quarter to 2.7 and 4.1 respectively 2nd and 3rd quarters in 2016. Even though there was a growth in industrial and service sectors respectively, 6.8 % and 4.7 %, while declining in the agricultural sector by -1.9 %. With this scenario food and beverages (F& B) sector represent 67% out of total market, which is 8.9% growth compared to 2015 and represent the 8.1 % general trade in the Sri Lankan market. Under the F & B segment, FMCG is the highest contribution category with LKR 226 billion value sales in general trade and 259 thousand FMCG universe in Sri Lanka which is 7% growth in 2016 compared to 2015 as a category by contribution of 64% from rural and 36% from urban segments. Considering the channel responsiveness for the FMCG market, while supermarket and mini supermarket are declining respectively from 23%, 24% to 19%, and 23% in 2016 compared to 2015 and general trade stores have increased from 49% to 56% in 2016, compared to 2015. Considering the advertisement expenditures of Sri Lanka, which is valued LKR 90 Billion in 2016, it is 5% growth compare to 2015

representing 70% TV, 22% Radio and 8% print media. Among these shares, 45%, 17%, 9% are respectively captured by the FMCG category which is 12% growth in 2016 compared to 2015. Therefore, the researcher considered the FMCG market for examination. Biscuits is the highest in the contribution category for the FMCG basket with 81,372 Metric tons volume and LKR 35,980 million value business category and which has growth of 3.4% by volume and 4.4% by value in 2016 compared to 2015. There are 49 companies currently operating with 1817 product under different brands in the categories: Cracker Biscuits, Sweet Biscuits, Savory, Cream and Biscuits and price categories is: less than Rs.20.00, Between Rs. 21.00 to Rs. 50.00, Between Rs. 51.00 to Rs.100.00 and above Rs. 100.00 rupees. Compared to 2014 with 2015, in the less than Rs.20.00 range, 108 items were introduced in 2015 and between Rs. 21.00 to Rs. 100.00 there were 117 new products introduced and above Rs. 100.00 rupees there were 64 new products introduced in 2015. These 1817 products are available in following number of outlets over the country. 2,090 Chemist, 115 Cosmetic shops, 130,292 Grocery shops, 20,995 Restaurants and 6,742 other shops and totally 160,234 outlets in 2015.

3. Research Problem

New product development and brand extensions are interrelated. Innovation also contributes a major role in new product development. According to (Thamariselvan, 2008), in current powerful competitive business environment, many companies introducing many products to satisfy constantly changing consumer's preference and needs in different manner. Sometimes these new products are failure due to several factors. Most of the time consumers also will not prefer to take the risk on their purchasing. Therefore, companies take efforts to reduce new products and innovation failure rates to maximize their returns for the stakeholders. A brand extension strategy is one of such strategy to reduce the failure of new products in the market whilst leverage the existing brand names to new product categories. Further creating the new brand is also high cost. The FMCG segment in Sri Lanka has strong growth momentum in Sri Lanka and globally. To cater to the increasing market demand for new products, companies are leveraging their parent brand names to launch new products or variants in Sri Lanka and globally. The literature shows that very few studies have been done on the FMCG sector and brand extension area and those that are done are based on foreign markets. Additionally, lack of empirical evidence in the Sri Lankan context related to brand extension strategy and parent brand equity specially referring on biscuit industry and this area of study has been investigated by many authors, Agrawal and Maheswaran, 2005, Henrik Sattler-2014 & 2016, Richa Joshi &Rajan Yadav, 2017, Chung-Yu Wang, Li-Wei Wu, Chen-Yu Lin and Ruei-Jie Chen 2017 and many studies are done based on some building blocks of brand equity rather than considering the whole area of brand equity. Considering the biscuits industry of Sri Lanka, there are 49 active

companies and 461 active sub-brands and 24 new SKU's have introduced in last year to the General trade. These theoretical, literature and practical gaps motivated researcher to choose this topic with using brand commitment as a moderating factor. Therefore, in this study the researcher tries to analyze ***“how do brand extension impact on parent brand equity on local branded biscuits products of Sri Lanka”.***

4. Key Objective

To identify how brand extension impacts parent brand equity on local branded biscuits products of Sri Lanka.

Specific Objectives

- 1 To carry a comprehensive theoretical analysis over concept of brand, brand elements, brand extension, parent brand equity, brand commitment and their relationship
- 2 To critically assess the impact of brand extension towards parent brand equity on local branded biscuits products of Sri Lanka.
- 3 To examine the impact of brand commitment between the brand extension and parent brand equity on local branded biscuits products of Sri Lanka.
- 4 To provide recommendations to overcome issues on impact of brand extension strategies towards brand equity on local branded biscuits products of Sri Lanka.

5. Significance of study

This study will help brand managers, marketing managers of current & a future biscuit manufacturer to evaluate their brand strength and weaknesses and they can rebuild the brand development strategy or keep development with the current strategy to survive in the market. To future researchers, the outcome of this study will provide some findings regarding brand extension on brand equity to do additional research in the field. At the same time, investors can apply the outcome of this study to identify future growth of the industry and invest accordingly.

6. Overview of Methodology

In this study the researcher follows the epistemology research paradigm scope to prove the facts and information related to this study. Further, the researcher intended to continue this study based on structured methodology to generalize the output with quantifiable observation and evaluate the result with the help of statistical methods. Therefore, the researcher follows the Positivism philosophy for this study and uses deductive approach since this study is mostly from a theory and practical perspective. Therefore, the researcher used the quantitative method and used the survey techniques with researcher administrated questionnaire, used the primary data and secondary data and considered biscuits consumers as a unit of analysis.

7. Limitation of the study

Even though the study tries to find out the objectives of this research, there are some limitations in this study. This study has following limitations:

The restraint of the sampling coverage:

The questionnaire survey is planned to be conducted at Kandy and Colombo Districts among the age groups of 18-45 years biscuits consumers. Even within that testing area only 384 consumers were selected to analyze the factors.

Lack of generalization of the study findings:

This study is limited to the branded biscuits industry. It is unknown if the result can be applied to other industries. Thus, further investigation is required if this is to be applied to other industries.

8.Literature review

Brand

Today the brand is essential to human life. We all start our day with a branded toothpaste and it ends with several branded goods and services. Concerning the brand, it always carries a particular level of quality, trust-worthiness and distinctive position among a dizzying array of choices in any kind of product or service.

‘Brand’ has been explained by many authors in different perspectives with their experiences in the field of marketing. Traditionally brand is explained as the name associated with one or more items in the product line, which is used to identify the source of character of the item (Kotler, 2000). Marketers created the brand when they create a new name, logo, or symbol for a new product (Keller K. , 1993,1998).

Brand Strategies

As earlier explained, that brand strategies are different based on the brand type which means, these types may be a functional brand or an image brand or an experiential brand. Marketers practice different strategies to expand and win their operating market. Professor (Kotler, 2003) classified these brand strategies into five areas such as line extension, brand extension, multi brand, new brand and co-branding. Among those, brand extension strategy is the one of main areas and the organizations are interested to follow this.

Brand Extension

Brand extension is a widely used strategy in brand management and extensively used in FMCG segment. History of this strategy initially communicated in 1967 by Gamble (Gamble, 1967). But originated in 1988 as a key to successfully stretching a brand is to view brand extension as a strategic tool by Dr. Edward Tauber (Tauber E. , 1988). With this background, determination of the name and

identification of the product is an important task of companies when designing product strategies and they also consider all above discussed brand elements. All manufacturing companies know that their product brand is a source of power that is backed by the market (Philip Kotler, 2008). As stated earlier, with consumers' needs being increasingly different, companies try to innovate and introduce solutions to cater to such needs. This helps differentiate themselves in the competitive market. Companies try to create strong brands and try to gain more profit whilst reducing their marketing cost (Keller, 2001, 2003). Consumers with a high level of commitment fail to consider category fit when evaluating brand extensions. (Seyed Mohammad Alavinasab, 2017) Did a research on the effect of brand extension strategy upon brand image based on home appliances and mobile phone industries with using random sampling method among 376 LG consumers. Their conceptual model includes five variables; initial brand image, perceived fit, perceived quality, consumers' attitude and final brand image. They found that initial image of the brand has positive, significant impact on consumers' attitude towards brand extension as well as final image of brand. (Ali Kazemi, 2013) Did an analysis about the effect of brand extension strategies upon brand image in the mobile market of Iran. The study found that found brand image quality of brand extension strategy has influenced by brand's image but the influence of the perceived quality of the product on consumer's attitude to new product has not been approved.

Brand Equity

Brand equity is one of the most significant areas in the field of marketing and which has been explained by several authors with many models. But there is no specific definition for brand equity. The Marketing Science Institute defined brand equity as: "the set of associations and behaviors on the part of the brand's customers, channel members and Parent Corporation that permits the brand to earn greater volume or greater margins than it could without the brand name and that gives a brand a strong, sustainable and differentiated advantage over competitors" and The American Marketing Association defined brand equity as "the intangible assets and goodwill associated with a brand". Further, Keller used depth of the brand awareness. This refers to how customers can easily recall and recognize the brand and breadth of the brand awareness: the range of purchase and consumption situation where the brand comes to mind for analysis of salience or brand identity. In the analysis of the brand, Keller used primary characteristics and supplementary features, Product reliability, durability and serviceability, service effectiveness, efficiency and empathy, Style and design and Price (Brand performance). It depends on mainly three factors such as Strength – how the brand is strongly identified with brand association, Favorability – how the brand association is valued for customers and Uniqueness – how distinctively the brand identified with brand association. To analyze the brand responses, Keller used the quality of the brand, credibility, consideration, and superiority to measure the judgement and warmth, fun, excitement, security, social approval, and

self-respect to measure the feelings. Further, behavioral loyalty, attitudinal attachment, sense of community and active engagement are used to measure the brand resonance to explain brand relationship. In this review, researcher focuses on the Kellers' customer-based brand equity components to explain the dependent variable.

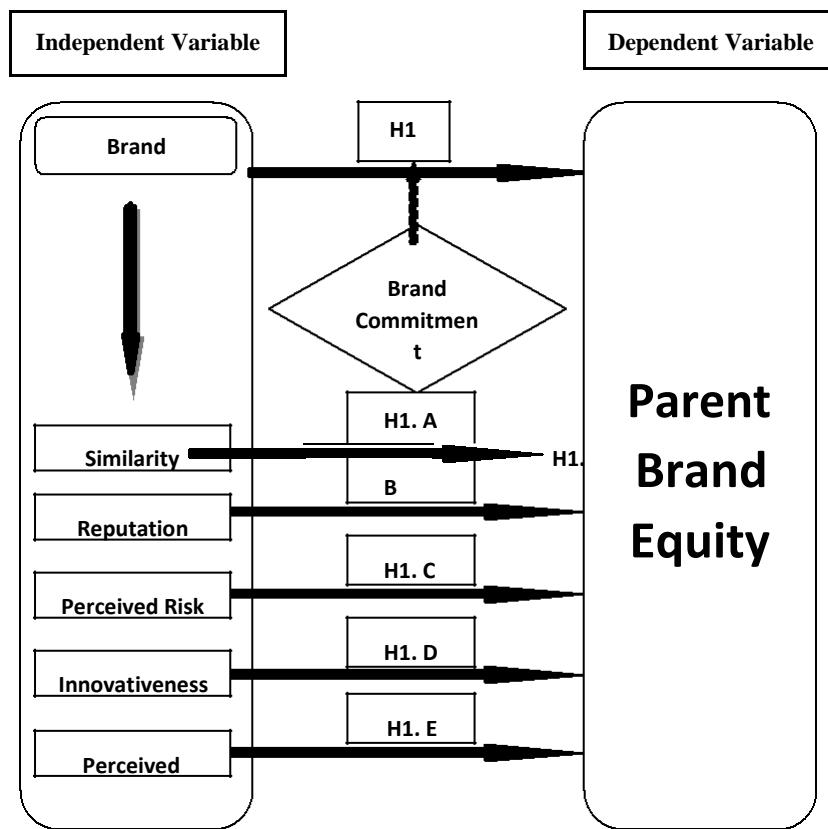
Brand Commitment

“Brand commitment” was viewed in different aspects by different authors. But, in general it can be viewed as how a consumer is committed to a particular brand. Kiesler (1971) explained this commitment as a sense of psychological attachment to an attitude object. Agrawal and Maheswaran (2005) further explained commitment as an improved desire to hold a specific attitude and pledges or binds the individual to a specific type of behavior. Raju S., Unnava R, Montgomery N, (2009) clarified this commitment in individuals as ‘commitment is driven by consumer experience with a brand and different forces around an individual’. Porter, Lyman W., Richard M., Steers, Richard T. Mowday, and Paul V. Boulian, (1974) explained commitment is based on emotions and sentimental attachments to the object. Further they stated that commitment deals with customer preference and positive feelings for the relationship partner. (Raju et al, 2009) specified that committed individual customers feel tied to a brand and are not ready to change brands as compared to less committed customers. Agrawal and Maheswaran, (2005) stated that less committed customers hold weak attitudes and fail to retain reliable beliefs regarding the target band. (Zohdi V., Lim K., Pearson J. T., Black M. J. (2015) stated that on the extended brand, association commitment has a positive influence on brand extension via parent equity. The consumer attitude will be better towards an extension when a consumer regularly buys a particular brand or interest or commitment to repurchase (Volckner and Sattler, 2006). According to (De Ruyter and Wetzels, 2000; Czellar, 2003). When brand commitment increases, extension credibility and brand extended product congruency will increase. According to (Fedorikhin, Alexander, C. Whan Park, and Matthew Thomson; 2008) a person highly attached to a specific object tends to be committed to preserve their connection to it.

9. Conceptual framework

Based on the literatures, the following conceptual framework has been developed to further study this research.

Figure 01 - Conceptual framework



10. Hypotheses development

To demonstrate relationship of the aforementioned variables in the conceptual framework following hypotheses have been developed based on brand strategies as a positive effect on brand equity. Tung (2010) in the research on “an integrated relationship on brand strategy, brand equity, customer trust and brand performance-an empirical investigation of the health food industry” and as stated in literature review, since Rastogi (2012), Abdul Hameed (2014), Chung-Yu Wang (2017) have mentioned that brand commitment is a moderating factor which influences the relationship of Brand Extensions on Parent Brand equity based on the level of brand commitment.

H1: Brand extension positively affects parent brand equity with reference to branded biscuitsproducts of Sri Lanka.

H2: The effect of brand extension on parent brand equity has a relationship with consumer brandcommitments referring to branded biscuits products of Sri Lanka.

H1. A: Similarity positively affects parent brand equity

H1. B: Reputation positively affects parent brand equity.

H1. C: Perceived risk positively affects parent brand equity.

H1. D: Innovativeness positively affects parent brand equity.

H1. E: Perceived quality positively affects parent brand equity.

Instrument and Measures

In this study, the researcher follows the epistemology research paradigm scope to prove the facts and information and Positivism philosophy. Further, the researcher uses the deductive approach since this study is from a theory and practical perspective. The researcher follows the quantitative methods and uses primary data for research since it is the most prominent. To collect data, the researcher used survey techniques under the quantitative approach. The researcher will use biscuit consumers as an individual unit of analysis. As mentioned earlier, for primary data collection in the survey technique, the sample from Colombo and Kandy districts biscuits consumers by using questionnaires was used which has been developed through previous articles and models in measuring brand extension and brand equity. All data will be collected by the researcher by the researcher-administrated questionnaires. The researcher uses the five point's Likert scale to measure the information. The researcher uses the descriptive and inferential data analysis methods and to test the hypotheses, uses the multiple regression analysis method. For the final analysis use the SPSS data analysis package.

Questionnaire design

To conduct the survey, the researcher has developed the questionnaire based on the variable operationalization and working definitions of variables which consist mainly of two sections such as section A and B. Both sections covered with 49 questions. Questions No 1 - 4 refer to the demographic information of respondents, Questions No 5-16 refer to the independent variable, Questions No 17-41 refer to the dependent variable and Questions No 42-49 refer to the moderating variable.

Sample population

The researcher decided to conduct the research in Kandy and Colombo Districts in the country. Therefore, the researcher estimated the sample population based on the Department of Senses and Statistics population counting report of 2012. According to the report, the Kandy district has 1,375,382 people and Colombo District has 2,324,349 people. Therefore, total estimated population is 3,699,731 for this study.

Sample Size

Sample size calculated by using the sample calculator with considering 95 % of confidence level and 5 % of confidence interval. Further, this calculation is highly matched with the Krejcie and Morgan (1970) sample size determining table. With the support of that, the researcher determines the sample size as 384 and expecting to distribute the questionnaire based on the population distribution percentage among these two districts as 63% in Colombo District and 37% in Kandy District.

Sample

The researcher considers the biscuit consumers as a unit of analysis, males and females with reference to age group 18 - 45 years from Kandy and Colombo districts. Convenient sampling method will be tested among the 384 target customers. This age group of sampling has proved that they consume 96 % of biscuits by Survey Research Lanka Pvt. Limited. (SRL) consumer tracking. (SRL- consumer track- April, 2014)

Data analysis & research result.

Respondent Profile

As aforementioned in the instrument and measures, the researcher collected the information through 380 questionnaires by the researcher administrated according the planed sampling. Validation of the sample refers 100%. Based on this back ground the researcher profile the respondent as follows, Gender of Respondents; In this study respondents response 54 % from male and 46 % from female sector. Districts of respondents; According to the respondents, they have divided in to two districts as Kandy and Colombo. The researcher got done the survey in these districts respectively 58 % and 42 %. Age of respondents; According to the planed sample the researcher could find the following age category respondents and they are 24 % from 18-24 years, 47 % from 25- 31 years , 10 % from 32 - 38 years and 19% from 39-45 years.

Reliability Test

According to Lynne (2011, p.45) that “Cronbach’s alpha measures the internal consistency of an instrument or scale”, and it measures the correlation between items. The higher Cronbach’s alpha is, the higher the items correlate with each other. Lynne also mentions Cronbach’s alpha which is above 0.95 indicates “a high degree of consistency between items and low measurement error”, Cronbach’s alpha which is from 0.70 to 0.80 is “regarded as satisfactory, Cronbach’s alpha 0.35 to 0.7 considered as fair reliability and Cronbach’s alpha less than 0.35 is taken as low reliability.” (Lynne, 2011, p.45) Similarity, Reputation, Perceived Risk and innovativeness are respectively referring 0.734, 0.728, 0.782 and 0.756 Cronbach’s Alpha value. Those are in between 0.70 to 0.80. Therefore, these variables shows satisfactory level. Perceived quality, Parent Brand Equity and brand Commitment are respectively referring 0.865, 0.877 and 0.808 Cronbach’s Alpha Value. Overall Cronbach’s Alpha value of questionnaire is 0.934 , the result illustrates that the overall consistence of the questionnaire of this study is highly reliable.

Validity Tests - Factor analysis

The researcher intended to test the validity of the instrument for further clarification. According the factor analysis of this study, principal component analysis value of each dimensions is greater than 1, each facet’s factor loading is between 0.500 and 0.939 and cumulated explained variances are all

greater than 50 percent. It's illustrate the questionnaire used in this study meets the relevant requirement of construct validity.

Descriptive Statistics

Considering each independent variable of this study refers to the descriptive statistics of the SPSS analysis, the researcher tries to explain the central tendency. Central tendency of the Similarity is 3.398 which is less than 3.67 it means central tendency is medium. Central tendency of the Reputation is 3.431 which is between 2.33 and 3.67. It means central tendency of Reputation is medium. Central tendency of the Perceived risk 3.286 which is between 2.33 and 3.67. It means central tendency of Perceived risk is also medium. Central tendency of the Innovativeness is 3.348 which is between 2.33 and 3.67. It means central tendency of Innovativeness is medium. Central tendency of the Perceived quality is 2.475 which is between 2.33 and 3.67. It means central tendency of Perceived quality is medium.

Pearson Correlation Analysis

This study uses the Pearson correlation analysis to confirm the correlation of two dimensions and the correlation. Coefficients of respective variables Similarity, Reputation, Perceived risk, Innovativeness and Perceived quality tested with 384 respondents and show the significantly positive correlation with the Parent brand equity respectively 0.547, 0.721, 0.580, 0.523 and 0.644.

Multiple Regression Analysis

As the researcher planned in the research methodology here, the simple and multiple regression analysis is used to test the hypotheses. Following table 1- 3 refers to the output of multiple regression analysis of this study.

Table 1: Model Summary

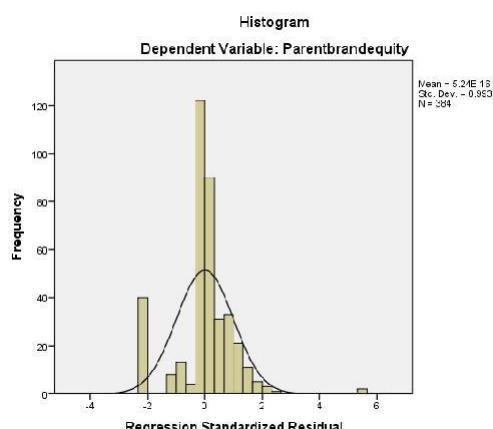
Model Summary									
Mod el	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.739 ^a	.546	.544	7.70558	.555	143.278	5	378	.000
a. Predictors: (Constant), Perceived quality, Innovativeness, Reputation, Similarity, Perceived risk									
b. Dependent Variable: Parent brand equity									

Table 2: ANOVA

ANOVA						
Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	42536.335	5	8507.267	143.278	.000 ^b
	Residual	22444.142	378	59.376		
	Total	64980.477	383			
a. Dependent Variable: Parent brand equity						
b. Predictors: (Constant), Perceived quality, Innovativeness, Reputation, Similarity, Perceived risk						

Table 3: Coefficients

Coefficients						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	37.917	3.453		10.980	.000
	Similarity	-1.877	.432	-.230	-4.344	.000
	Reputation	4.201	.345	.563	12.183	.000
	Perceived risk	1.335	.674	.118	1.980	.048
	Innovativeness	.050	.673	.004	.074	.941
	Perceived quality	3.034	.263	.473	11.551	.000
a. Dependent Variable: Parent brand equity						

Figure 2

Based on the above analysis the researcher could found that correlation between observed and predicted values of dependence variable is 0.739 alpha and R Square is 0.546. Root mean squared error is significant and **ANOVA** explains the analysis of above output as regression 42536.335, residual 22444.142 and total value refers 64980.477. Therefore, the model is fit. Furthermore, will explain through the hypotheses test.

Hypotheses Test

H1: Brand extension positively affects parent brand equity referring branded biscuits products of SriLanka.

As stated, model is fit since correlation between observed and predicted values of dependence variable is 0.739 alpha and R Square is 0.546. Root mean squared error is significant and **ANOVA** explains the analysis of above output as regression 42536.335, residual 22444.142 and total value refers 64980.477.

Table 4: Coefficient

Coefficients						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	27.028	3.518		7.683	.000
	Brand extension	1.520	.071	.739	21.416	.000

a. Dependent Variable: Parent brand equity

Considering the report (Table 05) of SPPS as above the researcher could found that the Brand extension represents the B value 1.520, t- value 21.416, and significant value 0.000. Coefficient of independent variable Brand extension is 1.520 significantly different from 0 because its P/ Sig. value is 0.000. Significant value 0.00 is less than 0.05. It refers that the independent variable Brand extension is a positive effect on parent brand equity. So, a hypothesis **H1** is tested and accepted.

Based on the table 04 of multiple regression analysis all the hypotheses are tested.

H1. A: Similarity is a positive effect on parent brand equity

Considering the report of SPPS as above the researcher could found that the Similarity represents the B value -1.877, t- value -4.344, and significant value 0.000. Coefficient of independent variable Similarity is -1.877 significantly different from 0 because its P/ Sig. value is 0.000. Significant value

0.000 is less than 0.05. It refers that the independent variable Similarity is a positive effect on parent brand equity.

So a hypothesis H1.A is tested and it is accepted.

H1. B: Reputation is a positive effect on parent brand equity.

Considering the report of SPPS as above the researcher could found that the Reputation represents the B value 4.207, t- value 12.783, and significant value 0.000. Coefficient of independent variable Reputation is 4.207 significantly different from 0 because its P/ Sig. value is 0.000. Significant value 0.000 is less than 0.05. It refers that the independent variable Reputation is a positive effect on parent brand equity.

So a hypothesis H1.B is tested and it is accepted.

H1. C: Perceived risk is a positive effect on parent brand equity.

Considering the report of SPPS as above the researcher could found that the Perceived risk represents the B value 1.335, t- value 1.980, and significant value 0.048. Coefficient of independent variable Perceived risk is 1.335 significantly different from 0 because its P/ Sig. value is 0.048. Significant value 0.048 is less than 0.05. it refers that the independent variable Perceived risk is a positive effect on parent brand equity.

So a hypothesis H1.C is tested and it is accepted.

H1. D: Innovativeness is a positive effect on parent brand equity.

Considering the report of SPPS as above the researcher could found that the Innovativeness represents the B value 0.050, t- value 0.074, and significant value 0.941. Coefficient of independent variable Innovativeness is 0.050 significantly different from 0 because its P/ Sig. value is 0.941. Significant value 0.941 is greater than 0.05. It refers that the independent variable Innovativeness is not a positive effect on parent brand equity.

So a hypothesis H1.D is tested and it is rejected.

H1. E: Perceived quality is a positive effect on parent brand equity.

Considering the report of SPPS as above the researcher could found that the Perceived quality represents the B value 3.034, t- value 11.551, and significant value 0.000. Coefficient of independent variable Perceived quality is 3.034 significantly different from 0 because its P/ Sig. value is 0.000. Significant value 0.00 is less than 0.05. It refers that the independent variable Perceived quality is a positive effect on parent brand equity.

So a hypothesis H1.D is tested and it is accepted.

H2: The effect of brand extension on parent brand equity has a relationship with consumer brandcommitments referring to branded biscuits products of Sri Lanka.

Moderating factor also tested through regression analysis in table 23-25, which also found that correlation between observed and predicted values of dependence variable is 0.807 alpha and R Square is 0.652. Root mean squared error is significant and ANOVA explains the analysis of above output as regression 42342.607, residual 22637.869 and total value refers 64980.477. Therefore, the model is fit.

Further, comparing the models as stated in table 19 and 23, alpha and R Square values have changed and Adjusted R Square is .650 with the moderating factor. Earlier it was 0.555. it means moderating factor brand commitment has some relationship relate to Brand extension and parent brand equity

Table 05: Model Summary

Model Summary					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	
1	.807 ^a	.652	.650	7.70824	
a. Predictors: (Constant), Moderator brand commitment, Brand extension					

Table 06: ANOVA

ANOVA						
Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	42342.607	2	21171.304	356.317	.000 ^b
	Residual	22637.869	381	59.417		
	Total	64980.477	383			
a. Dependent Variable: Parent brand equity						
b. Predictors: (Constant), Moderator brand commitment, Brand extension						

Table 07: Coefficients

Coefficients						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	13.129	3.344		3.926	.000
	Brand extension	1.728	.065	.840	26.524	.000
	Moderator brand commitment	7.908	.734	.341	10.768	.000

a. Dependent Variable: Parent brand equity

Considering the report of SPSS as above, the researcher found that brand commitment represents the B value 7.908, t- value 10.768, and significant value 0.000. Coefficient of independent variable brand commitments is 7.908 significantly different from 0 because its P/ Sig. value is 0.000. Significant value 0.00 is less than 0.05. It refers that the independent variable brand commitments is positively affect on parent brand equity.

So a hypothesis H2 is tested and it is accepted. Further it was found that Brand commitment has a positive relationship with brand extension and Parent Brand equity.

11. Findings

The purpose of this study was to examine the interrelationship between the brand extension and parent brand equity and impact of brand commitment as a moderating factor referring to the branded biscuits products of Sri Lanka. For this study the conceptual model was developed based on (Chernatony, 2001,2003), (Czellar, 2003) (Seyed Mohammad Alavinasab, 2017), (Keller K., 1993, 1998), (Albert and Merunka, 2013), (Fullerton, 2005), (Belaid and Behi, 2011) and (Jones et al., 2010). All variables used in this study are accepted by the previous researchers based on different industries and are still recommended for further study. As stated earlier, most of these studies only considered one or two variables of independent and dependent concepts. The significance of this study is that the researcher has taken consideration of all variables and did the study referring only to the local branded biscuit products. According to the literatures of Tung, 2010; Rastogi, 2012; Abdul Hameed, 2014; Chung-Yu Wang, 2017 the researcher developed the hypotheses which were expressed as overall brand extension variables have positively affected the parent brand equity and moderating factor also have a positive relationship on brand extension and parent brand equity. But based on the result obtained in this study referring to branded biscuits products of Sri Lanka, that was completely different from previous studies. Some of the hypotheses were accepted and some, rejected. Considering the study results, Similarity, Reputation, Perceived Risk, and Perceived Quality variables positively impacted parent brand equity. But Innovativeness does not positively affect the parent brand equity referring to the branded biscuits products of Sri Lanka. Further, overall brand extension has a positive relationship on parent brand equity referring to the branded biscuits products of Sri Lanka. Furthermore, brand commitment also has a positive impact towards brand extension and parent brand equity relationship.

12. Conclusions

With the personal selling and management experience of the researcher for past fourteen years in FMCG market who found that Sri Lankan consumers are mostly of the mindset of relying on previous experience on any kind of new purchasing. Mainly when consuming a product like biscuits, they match the experience that they had with a particular brand and to seek similarity, pay their attention on brand reputation, willingness to reduce the perceived risk, and expect the perceived brand quality and always hesitate to switch to new brands and products. That real experience made the researcher more confident in the data collection period of this study. Therefore, the researcher could find that most sample units were highly positive, contributing to the questions of similarity, reputation, perceived risk and perceived quality. According to the Multiple Regression analysis of this study, the SPSS reports show that significant value of each independent variable; Similarity, Reputation, Perceived Risk, and Perceived Quality are less than the 0.05. The significant value of innovativeness is greater than the 0.05. Furthermore, considering most of the references attached to this study have been done in foreign countries and based on international brands. Even in most of those literatures, all brand extension determinants have a positive effect on parent brand equity. But considering Sri Lankan Market, especially referring to the branded biscuits products of Sri Lanka, the researcher could not find that all brand extension determinants have positively affected parent brand equity. The findings of this study prove that similarity, reputation, perceived risk and perceived quality positively affect parent brand equity referring to the branded biscuits products of Sri Lanka and innovativeness does not positively affect parent brand equity referring to the branded biscuits products of Sri Lanka. But in previous studies, brand commitment has shown that positive relationship with the brand extension and parent brand equity.

13. Recommendations

Managerial Implication

According to the findings of this study, some brand extension variables have a positive impact on parent brand equity. Therefore, those variables can be used to develop brand names and those can be practiced by brand executives, brand managers and brand owners when new products are launched. Marketing and advertising agencies; mainly brand managers, should consider these factors well while developing marketing activities and program. Specially, in the brand activation part, all brand managers have a high responsibility to pay their concern on these brand extension determinants. Since brand extension gives many benefits to the organization and missing developing brand will lead to brand failure. Some giants in the biscuits industry of Sri Lanka are practicing this well and current competitors of these giants also can practice these brand extension concepts systematically to develop their business in terms of market and mind share.

14. Further research

Change different products and brand and find the impact of the brand extension on parent brand equity to win the market. Change the industry to be studied in new research: since this study refers only to the branded biscuit industry, sometimes this finding may affect different ways for some other industry and this finding may be useful for those who hope to do so in the field of research related to the brand extension.

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Virtual Laboratory – A Learning Enhancement Experience through NLP Application Design

Mrs. Beena Kapadia

Assistant Professor

Dept. of Information Technology,
Vidyalankar School of Information Technology,
Wadala, Mumbai.
Email: beena.kapadia@vsit.edu.in

Dr. Amita Jain

Assistant Professor

Vidyalankar School of Information Technology,
Wadala, Mumbai.

Email: amita.jain@vsit.edu.in

ABSTRACT

One challenge for teaching fraternity in current pandemic situation is to provide online virtual laboratory experimental education for various Information Technology and computer science courses, along with online lectures to students with a view that they feel like they are sitting in the physical laboratory and understanding and performing experiments, though it is virtual. This paper shares our experience of using Natural language Processing (NLP) virtual Lab for learning morphology, in which we have used various multimedia software which are open source.

Keywords: *virtual, laboratory, NLP, Morphology, open source*

1. INTRODUCTION

A virtual laboratory is a computer-based activity where students interact with the simulator. It can have no physical reality behind it at all. Morphology is a branch of linguistics to convey how words are formed from morphemes. The dictionary meaning of morphology is - the form of words, studied as a branch of linguistics

This paper aims to provide the complete design of Morphology – one of the NLP applications and provides the idea to students about what morphology is and how it is applicable to different languages. They can practice it with different root words given in the dropdown menu and apply their morphological ideas to the table. Upon getting the correct selection of ‘matra’, they can get the correct answer. Else, individual wrong mark in red will be displayed against that row of the table.

2. LITERATURE REVIEW

Virtual laboratory is also referred as Computer Based Simulation, Virtual Learning System, Virtual Lab System or just Simulations. Under the National Mission on Education through ICT the Ministry of Human Resource Development has initiated the Virtual Labs project. These labs will now be used by the students all over the country. In this paper, we are describing the steps for NLP Morphology Virtual laboratory by taking reference of existing virtual labs.

The traditional laboratories are easy to use and may sometimes be less expensive, but the virtual laboratories provide many advantages than the traditional labs. The virtual labs if properly designed taking into consideration the online multimedia instructional design principles can enhance the skills in the students. Due to the availability of virtual laboratories at anytime and anywhere, can give the students an opportunity to explore the experiments and reflect on the results obtained.

NLP is a field of Computational linguistics and is associated with human to convert information from computer to natural language using NLG (Natural Language Generator) and to convert reverse way using NLU (Natural Language Understanding). There are many Indian languages but mostly we consider Hindi language as an Indian language, when we compare it with English.

3. IMPLEMENTATION OF NLP MORPHOLOGY APPLICATION:

The virtual laboratory is designed using html, CSS and Java script, which are open source. This virtual laboratory is made user friendly, in which students can interact while operating the simulator of morphology. We have included total eight steps in this virtual laboratory, namely Broad Goal, Learning Objectives, Theory, Pre-Test, Procedure, Simulator, Post Test and References.

Broad Goal: The Broad Goal of the experiment is to understand the morphology of a word by the use of Add-Delete table.

Learning Objectives: Students will be able to select the root word, delete the tense from the word to find the stem of the word, add the appropriate tense to make it the correct word asked as either singular or plural with direct (nominative like - he, they) case or singular or plural with oblique (like him, them) case, check whether the selected tense is correct as per the asked in the question, get the correct answer if couldn't complete it correctly

Theory of Morphology: Morphemes are considered as smallest meaningful units of language. These morphemes can either be a root word (play) or affix (-ed). Combination of these morphemes is called morphological process. So, word "played" is made out of 2 morphemes "play" and "-ed". Thus, finding all parts of a word (morphemes) and thus describing properties of a word is called

"Morphological Analysis". For example, "played" has information verb "play" and "past tense", so given word is past tense form of verb "play". Another example of Morphology is Motivation having various forms - motiv, motivate, motivation.

Procedure: There are only three steps to be followed by the user to operate the simulator. Users should select a word root, Fill the add-delete table and submit.

If students submit the correct pre or post word as asked in the question to convert the root word into singular or plural, past or present tense like un, s, es, ed, ing etc then the right mark in green displays and upon selecting the wrong pre or post word, a wrong mark appears in red color. If the answer is incorrect, then student has to again start from the step 1.

NLP Morphology Virtual lab

[Broad Goal](#) [Learning Objectives](#) [Theory](#) [Pre Test](#) [Procedure](#) [Simulator](#) [Post Test](#) [References](#)

Morphology Select a Root Word

Fill the add delete table here:

Delete	Add	Number	Case	Correction
અ	બચા	sing	dr	✓
અ	બચાં	plu	dr	✗
અ	બચો	sing	ob	✗
અ	બચા	plu	ob	✗

For Example for લાદકા:

Delete	Add	Number	Case
આ	ઝા	sing	dr
આ	ઝ	plu	dr
આ	ઝ	sing	ob
આ	ઝા	plu	ob

Error in your Add-Delete table!

Delete	Add	Number	Case
આ	આ	sing	dr
આ	એ	plu	dr
આ	એ	sing	ob
આ	આ	plu	ob

Figure 1(a): Overall design of virtual lab along with simulator with incorrect selection

NLP Morphology Virtual lab

[Broad Goal](#) [Learning Objectives](#) [Theory](#) [Pre Test](#) [Procedure](#) [Simulator](#) [Post Test](#) [References](#)

Morphology Select a Root Word

Fill the add delete table here:

Delete	Add	Number	Case	Correction
અ	આ	sing	dr	✓
અ	એ	plu	dr	✓
અ	એ	sing	ob	✓
અ	આ	plu	ob	✓

For Example for લાદકા:

Delete	Add	Number	Case
આ	ઝા	sing	dr
આ	ઝ	plu	dr
આ	ઝ	sing	ob
આ	ઝા	plu	ob

Correct Answer!

Figure 1(b): Overall design of virtual lab along with simulator with correct selection

Simulator: It is the main task of designing the virtual lab. The Simulator diagram is shown below as per our design. Figure 1(a) shows the Overall design of virtual lab along with simulator, with incorrection selection done by students while learning morphology whereas figure 1(b) shows the Overall design of virtual lab along with simulator, with correction selection done by students while learning morphology. If a student is clueless about what to select then he/she can click on the Get Answer button to get the correct answer and after studying it, he/she can apply his/her own answer again to simulator.

As per the step1, user or student has to select the root word. Then select the delete and add ‘Matra’ as per the asked in the question. Sing stands for singular, plu stands for plural. Ob stands for oblique case and dr stands for direct case. After selection done, user requires to click on submit button.

Upon selecting the correct answers, It shows all right marks in green in the table and displays the message ‘correct answer!’ in green.

There are pre-test and post-test designed to check whether student has understood it correctly or not. Students can appear any number of times to that test, basically because it is for improving their understanding and not for doing any kind of the evaluation. The pretest and post test are displayed in the figure 2(a) and 2(b) below:

NLP Morphology Virtual lab

[Broad Goal](#) [Learning Objectives](#) [Theory](#) [Pre Test](#) [Procedure](#) [Simulator](#) [Post Test](#) [References](#)

Answer the following questions after reading the Theory

Question 1.
----- should be deleted from the root word लड़का and ----- should be added to it to change it to singular and direct case.

आ and आ
 आ and ए
 आ and ए
 आ and औं

Question 2.
----- should be deleted from the root word लड़का and ----- should be added to it to change it to singular and oblique case.

आ and आ
 आ and ए
 आ and ए
 आ and औं

Number of score out of 2 = Score in percentage =

Figure 2(a): Pretest

Answer the following questions after using the Simulator**Question 1.**

----- should be deleted from the root word लड़का and ----- should be added to it to change it to plural and direct case.

- आ and आ
- आ and ए
- ए and आ
- आ and औं

Question 2.

Finding all parts of a word and thus describing properties of a word is called _____ Analysis.

- Morphological
- word
- structure
- root

Grade MeNumber of score out of 2 = Score in percentage =

Figure 2(b): Post test

CSS is designed to keep symmetry amongst all pages in terms of background, font size, borders etc. Java script is used to fetch the root word and also to fetch all words from the table and verify it whether the answer selected by student is correct or not. Accordingly, it displays the message. The submit button in html file calls the function in Java script to verify the answer.

4. FUTURE SCOPE:

This paper uses limited words for only one language. So, further enhancement can be done for all words of the language. But it seems difficult to do so. Other enhancement can be done that other Indian languages can also be added. For that one more dropdown menu can be kept in the beginning of the simulator about selection of languages. As per the language selected, some more words can be added for that language to study morphology. Further, in this paper we have worked mainly for noun but in future, more work can be carried out on verb and adjective also.

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Journal Particulars:

Title	Pradnyaa International Journal of Multidisciplinary Research
Frequency	Two issues in a year.
ISSN	2583-2115
Publisher	Vidyalankar School Of Information Technology
Starting Year	2021
Subject	Multidisciplinary
Language	English
Publication Format	Online
Website	www.vsit.edu.in

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Chief-Editor

Dr. Rohini Alok Kelkar
Principal,
Vidylankar School of
Information Technology,
Wadala-East
Mumbai, Maharashtra 400037
principal@vsit.edu.in
Tel No- 022-24161126



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