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## Contents

No.	Articles/Authors Name	Pg. No.
1	Effect of Branching Ratio for Nitrogen Laser System – <i>Nagmani Prasad Sinha &amp; P. Poddar</i>	1 - 6
2	Portrayal of Women by Media: The Changing Narratives – <i>Prof Pooja Rana</i>	7 - 12
3	A Study on Measures to Control of NPAs in Banks in Dakshina Kannada District – <i>Dr. M. Dhanabhakyam, Mrs. Usha Nayak</i>	13 - 16
4	The Influence of Tax and Tunneling Incentive on Transfer Pricing Decisions in Basic Industrial and Chemical Sector Companies and Trade, Service and Investment Sector Companies Listed on the Indonesian Stock Exchange (IDX) – <i>Alfian Maase</i>	17 - 32
5	Teaching AI in Knitwear Education, with reference to the application of Artificial Neural Networks (ANN) – <i>Nishant Sharma</i>	33 - 41



# Effect of Branching Ratio for Nitrogen Laser System

Nagmani Prasad Sinha,<sup>1</sup> & P. Poddar<sup>2</sup>

Ph D, Deputy of Executive Director of the Extra budgetary Pension Fund under the Ministry of Finance

## ABSTRACT

The effect of non-vanishing branching ratio on various parameters such as unsaturated population difference  $N(Z)$ , cascade transition rate (R) and the difference of population in terms of density matrix ( $\rho_{aa} - \rho_{bb}$ ) has been estimated for nitrogen laser system. The semi-classical formula of Lamb Jr. has been used for estimation of the difference of population in terms of density matrix. The present simplified analysis indicates how the branching ratio quantitatively to be used to the basic process involved in the laser system.

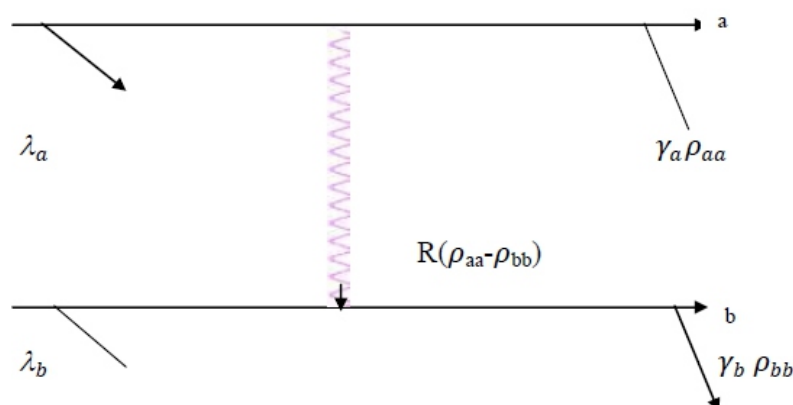
**Key words :** nitrogen laser, branching ratio, population difference, cascade transition, density matrix. PACS : 42.55. Lt, 42.60. By (both)

## INTRODUCTION

According to E. Wills & Lamb Jr.[1] the lower maser level could at least in part be excited by spontaneous emission from the upper. They have discussed a term branching ratio  $f$ . Recent Borah & Barua[2] have calculated branching ratio and its effect on various parameters in case of  $Ar^+$  laser system. Branching ratio effect on various parameters in He-Ne laser has been reported by author[3]. In present study we have calculated the branching ratio for Nitrogen laser system and shown its effect on various parameters.

## METHOD AND RESULT

Let the response frequency of the transition from Level 'b' to 'a'. is  $\omega$   
The number of atoms per unit volume per unit time excited to level 'a' and 'b' are  $\lambda_a$  and  $\lambda_b$  and the decaying rates are  $\gamma_a \rho_{aa}$  and  $\gamma_b \rho_{bb}$  respectively. The number making transitions[4] from the level 'a' to 'b' is  $R(\rho_{aa} - \rho_{bb})$ . The figure of transitions has been shown in Fig. 1]



**Fig. 1 :- The energy level diagram for the two level atoms comprising laser active medium.**

## INTRODUCTION

According to E. Wills & Lamb Jr.[1] the lower maser level could at least in part be excited by spontaneous emission from the upper. They have discussed a term branching ratio  $f$ . Recent Borah & Barua[2] have calculated branching ratio and its effect on various parameters in case of  $\text{Ar}^+$  laser system. Branching ratio effect on various parameters in He-Ne laser has been reported by author[3]. In present study we have calculated the branching ratio for Nitrogen laser system and shown its effect on various parameters.

## METHOD AND RESULT

The rate equations can be represented by

$$\begin{aligned}\dot{\rho}_{aa} &= -\gamma_a \rho_{aa} + R(\rho_{bb} - \rho_{aa}) + \lambda_a \\ \dot{\rho}_{bb} &= -\gamma_b \rho_{bb} + R(\rho_{aa} - \rho_{bb}) + \lambda_b + f \gamma_a \rho_{aa}\end{aligned}\quad (1)$$

where the source term of  $f \gamma_a \rho_{aa}$  describes the effect of radiative cascade excitation of 'b' from 'a'.

As shown in Fig. 1, In steady state the population density difference  $(\rho_{aa} - \rho_{bb})$  becomes :

$$\rho_{aa} - \rho_{bb} = \left[ \frac{\lambda_a}{\gamma_a} \left\{ 1 - f \left( \frac{\gamma_a}{\gamma_b} \right) - \frac{\lambda_b}{\gamma_b} \right\} \right] \times [1 + R \{ \gamma_a (1 + f) + \gamma_b \} / \gamma_a \gamma_b]^{-1} \quad (2)$$

It will be seen that the effect of a nonvanishing branching ratio  $f$  is merely to change the unsaturated population difference (obtained for  $R = 0$ ) and also to modify the value of  $R$  for which a given value of saturation parameter will be modified in an obvious fashion. Thus if  $f = 0$ , a value of  $R = \frac{1}{2} \gamma_a \gamma_b / \gamma_{ab}$  would cause 50% saturation, while if  $f = 1$  the value would be  $R = \gamma_a$ .

### The effect of branching ratio on various parameters

We have estimated that the nitrogen laser line 337.1 nm originated[5] from  $C^3 \pi_u$  to  $B^3 \pi_g$  level. For this decay chain we want to calculate the value of unsaturated population difference  $N(Z)$ , cascade transition rate ( $R$ ) and difference of population in terms of density matrix  $(\rho_{aa} - \rho_{bb})$  effect of branching ratio  $f$  on these parameters.

We know that, the branching ratio

$$f = \frac{A_{ij}}{\sum_j A_{ij}} = \frac{A_{ij}}{A_i} = \frac{\text{decay from upper level to lower level}}{\text{Total decay from upper level}} \quad (3)$$



Where,  $A_{ij}$  is the partial transition probability,  $A_i$  is the total probability for level i.

Now for decay chain,  $C^3\pi_u - B^3\pi_g$  i.e. for 337.1 nm line, the value of transition probabilities[5-6]

$$A_i = \frac{1}{t_i} = \frac{1}{10 \times 10^{-6} \text{ Sec}} = 10^5 / \text{sec} \quad (4)$$

$$\text{Similarly, } A_j = \frac{1}{t_j} = \frac{1}{40 \times 10^{-9} \text{ Sec}} = 2.5 \times 10^7 / \text{sec} \quad (5)$$

If  $n_i$  and  $n_j$  are the upper and lower level population and  $A_i$  &  $A_j$  are total probabilities for level i & j and  $\tau_i$  and  $\tau_j$  are the lifetimes[7]. We know that

$$\frac{n_i}{n_j} = \frac{A_j}{A_i} \quad (6)$$

Putting the values[8] of  $n_i$  &  $n_j$  in the above equation we obtained the value of

$A_{ij}$

$$A_{ij} = 1.1627 \times 10^3 / \text{sec} \quad (7)$$

Where,  $A_{ij}$  is the partial transition probability

$$\text{hence, the branching ratio } f = \frac{A_{ij}}{A_i} = 0.01163 \quad (8)$$

The inversion density[8]  $\left(\frac{n_i}{g_2} - \frac{n_j}{g_1}\right)$  of levels between which oscillation in  $N_2$

laser is observed, where,  $n_i$  and  $n_j$  are the upper and lower level populations,

and  $g_2$  and  $g_1$  are the usual statistical weight[9] of the upper and lower levels

respectively (at pressure 80 Torr and pulse repetition rate 15HZ) is given by

$$\frac{n_i}{g_2} - \frac{n_j}{g_1} = 21.499 \times 10^{13} \quad (9)$$

as  $g_1 = g_2 = 1$

$$\text{Hence, } n_i - n_j = 21.499 \times 10^{13} \quad (10)$$

Now, we can write the decay constants

$$\gamma_a = A_i = \frac{1}{10 \times 10^{-6} \text{ sec}} = 10^5 \text{ S}^{-1} \quad (11)$$

$$\gamma_b = A_j = \frac{1}{40 \times 10^{-9} \text{ sec}} = 2.5 \times 10^7 \text{ S}^{-1} \quad (12)$$

And the upper state population

$$n_i = 2.1 \times 10^{14} \quad (13)$$

$$\therefore \lambda_a = \frac{n_i}{\tau_i} = 2.15 \times 10^{19} \text{ S}^{-1} \quad (14)$$

$$\text{Similarly, } \lambda_b = \frac{n_i}{\tau_j} = 0.0537 \times 10^{23} \text{ S}^{-1} \quad (15)$$

Hence, the unsaturated population difference

$$N(Z) = \left[ \frac{\lambda_a}{\gamma_a} \left\{ 1 - f \left( \frac{\gamma_a}{\gamma_b} \right) - \frac{\lambda_b}{\gamma_b} \right\} \right] = 0.000925 \times 10^{14} \quad (16)$$

But the value of unsaturated population difference without f

$$N(Z) = \lambda_a \gamma_a^{-1} - \lambda_b \gamma_b^{-1} = 21.499 \times 10^{13} \quad (17)$$

Here the above it is apparent that the decrease in the value of unsaturated population difference is due to the presence of branching ratio. This also indicates gain in population of the lower level via excitation of this level through spontaneous decay from upper levels.

The cascade transition rate[10],

$$\begin{aligned} R &= \lambda_a \sum \tau C^3 \pi_\mu A C^3 \pi_u B^3 \pi_g \\ &= (2.15 \times 10^{19}) (10 \times 10^{-6}) (1.1627 \times 10^{13}) \\ &= 24.99805 \times 10^{26} \end{aligned} \quad (18)$$

Where  $\tau C^3 \pi_u$  is life time.  $A C^3 \pi_u$ ,  $B^3 \pi_g$ , Einstein A Coefficient connecting the states expressed in the subscript.

Therefore the denominator of the eq. (2), becomes

$$1 + R \frac{\{\gamma_a(1+f) + \gamma_b\}}{\gamma_a \gamma_b} = 25.097 \times 10^{21} \quad (19)$$

Now, the difference of population in terms of density matrix,

$$\rho_a \rho_a - \rho_b \rho_b = \left\{ \frac{\gamma_a / \gamma_a (1-f \gamma_a / \gamma_b) - \lambda_a \gamma_b}{1 + \frac{R \{\gamma_a(1-f) + \gamma_b\}}{\gamma_a \gamma_b}} \right\} = 0.0856642 \times 10^{-7} \quad (20)$$

This value of population difference in terms of density matrix is quite realistic and shows substantial inversion at the desired level.

## CONCLUSION

It is obvious from the present calculation that the effect of nonvanishing branching ratio f is to decrease the unsaturated population difference and hence to increase the excitation of the lower level.

The present study provides the use of the concept of branching ratio to analyse its effect on various parameters involved in the scheme in a quantitative manner. It is also apparent that the present calculation is simple but significant in this regard.

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The value of population difference[3] in terms of density matrix in case of He-Ne laser system is 0.713 whereas in case of nitrogen laser system is  $0.086 \times 10^{-7}$  according to the present calculation. This value is very less in comparison to the value 0.713 for He-Ne laser system. It shows one of the reason why He-Ne laser is continuous laser whereas Nitrogen laser is a pulse laser.

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# Portrayal of Women by Media: The Changing Narratives

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## **ABSTRACT**

Today media has saturated the globalised world. It is all pervasive to the extent of being omnipresent. Right from multiple television sets in our homes to newspaper at the doorstep, radio in the car, huge billboards all around, fliers in our inbox and most importantly this powerful gadget that has enslaved the world today – smart phone in hand – ensure that we are constantly being bombarded with media content in different formats. Media not only inform, educate and entertain us but also advertently or inadvertently influence our perceptions regarding the society that we live in. Researches prove that it is a potent force in influencing our opinions and shaping our beliefs. This paper attempts to examine how today's media portrays the Indian woman. The paper seeks to enquire if the Indian media today reinforces the stereotypical image of the Indian women or it represents the changing role of women. The paper concludes that the Indian media today acknowledges the changing role of the Indian woman to some extent. It also partially covers women-centric issues.

However, much is still left to be achieved. Media needs to make more sincere efforts to discuss women-centric issues that help women realize and gain their rightful place in the society. Media should also make more efforts to present women in a progressive manner rather than strengthening the stereotypes.

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**Keywords: Indian Media; Gender Narratives, Women Portrayal; Stereotype; Changing Role.**

## **1. INTRODUCTION**

India is a young democracy. It is in the 73rd year of independence. A lot has been achieved in different spheres and much is still required. In a young democracy like India which is still in the nascent stage of development, media is expected to play a socially responsible role. In fact, media should be the link between the government and the citizenry. Media is expected to bring up the issues of public importance into the public sphere for further debates and discussions or appropriate action by the competent authorities.

It must also aid development of the nation – be it social, economic, educational, rural etc. Watchdog journalism is also important for checking any wrongdoings or emerging trends which are detrimental to the very essence of democracy.

On one hand, the right kind of media content can positively reinforce beliefs that aid in keeping the social fabric intact and introduce changes in our perception of what is acceptable and what is unacceptable; on the other hand mindless media content can prove to be detrimental to bringing about social changes.

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There was a time when the media content creation was primarily in the hands of men; thus it projected women as per the man's preferences. Media, that time, projected the role of women as per the whims and fancies of men. Such content reinforced the already existing prejudices against women. However, the scenario changed with the coming of digital revolution. Modern technology aided the birth of new media platforms which offered an opportunity to both men and women to bring forth their side of the story. This provided a voice to women. Women started bringing their issues and concerns to discussion boards using the new technology. Thus, the ongoing digital revolution opened new possibilities of accelerating the process of upliftment of women. But if it is misguided and uncontrolled, then it will decelerate the dream of making India an egalitarian society. Hence, it is worthwhile to understand the way in which women are portrayed in media and also the way women-centric issues are taken up by the Indian media today.

The manner in which media of any State treats women issues and the way in which it projects women is partially indicative of the prevailing attitude of society towards women. If not indicative, it surely contributes towards stereotyping women as majority of content consumers consciously or unconsciously tend to believe that media is a reflection of our society. That could be true or far from truth, but there's no doubt that media influences the way we view the larger socio-cultural picture of the society. And precisely because of this reason the depiction of women in the Indian media has always been of interest and concern to the social scientists. In view of all this, one can safely infer that media – from the journalistic point of view as well as other media content like films, fictions, soaps etc – greatly influences our mindset and if used intelligently can play a significant role in aiding social change. To this end, the paper attempts to examine how today's media portrays the Indian woman. The paper seeks to enquire if the Indian media today reinforces the stereotypical image of the Indian women or if it represents the changing role of women. This paper attempts to examine the gender narratives in the Indian media today.

## **2. RESEARCH METHOD**

The researcher has collected the data for the undertaken study from secondary sources. The sources included books, research journals, magazines and web sites.

## **3. RESULTS AND ANALYSIS**

The Indian Media from the journalistic view point has also evolved over the decades. It has undergone an exciting journey from being a mission in the pre independence times to being recognized as a profession in early 70s to where it is today. Today, media is seen as an industry and being an industry, there are economic considerations as well. Also, one must remember that media in our country has been accorded a special status – the Fourth Estate—and this comes with a lot of responsibility.

Studies reveal that news and features relating to women get reasonable coverage in the mainstream newspapers and magazines today. Readers would agree that the front page of the morning newspaper does not ignore the gory crimes taking place against women. However, many a times one notices that the crime is sensationalized in order to increase the readership/TRP. Also, the picture is dismal if one talks about media coverage of social issues relating to women like equality of status and opportunity. Going by the statistics, it gets less than 9 percent coverage while sensational stories relating to women get almost 7 times more coverage. The sensational crime stories against women, especially from the upper strata of society, like Sheena Bora murder case not only get a better coverage in terms of space but also in terms of placement.

Some recent studies of news stories make us conclude that sex and sensation are the primary motivation behind the reportage.

The English mainstream dailies also dwell on commodifying women. Supplements along with the main newspaper are full of blow ups of scantily clad women. In the vernacular press too, the depiction of women essentially gets a decent share only on coloured pages. Newspapers give space to crime, sports, politics, women achievements etc but women issues in general are neglected.

And stereotyping doesn't stop here. Women magazines have almost ten times more ads and advertorials promoting the likes of weight loss, a fairer skin tone than men's magazines. Television and movies reinforce the importance of a thin body as a measure of a woman's worth. According to a research study by Oyindrila Basu and Shiva Raman Pandey there are false concepts of beauty and perfectionism that are widespread in India. Their study reveals that TV actors (females) remain under immense psychological pressure to stay slim and slender; which is resulting in a growing tendency of anorexia among them. According to recent reports, over 75% of female characters in TV are underweight, and only one in twenty is above average in size. Also, it is seen that overweight actresses tend to receive negative comments from male characters about their bodies. Today's models weigh significantly less than the average Indian woman. Researches indicate that constant exposure to images of size zero female bodies and body shaming can have adverse effects leading to depression, loss of self-esteem and development of unhealthy eating habits in women.

Depiction of female characters in daily soaps – be it the protagonist or on the periphery of the narrative – should also be a matter of concern to us. Many of the popular daily soaps are depicting women and young females in a manner which is far away from the reality. They are often shown as being involved in conspiracy, illicit love triangles, creating misunderstandings in the family and actively participating in family discords, suicidal love affairs little caring about anything else than the individual matters. The female protagonists would usually adorn expensive attire and heavy gold and diamond jewelry and often unaware of the outside world. This conservative and negative portrayal of women in daily soaps is far from the changing gender roles and social milieu and represents only a small part of the larger picture.

It is also interesting to note how these popular TV serials, through the portrayal of such characters, portray women in a manner that unfortunately does not do justice to the changing role of women in the Indian socioeconomic milieu. With the nation claiming to join footsteps in the march towards globalization and modernization where the State, with the help of its existing systems and new policies is aiming to strengthen the position of the marginalized women in our society, it does seem a little out of context to see contemporary TV serials and soaps projecting women more in a secondary role. The stereotypical characters of a wronged wife, a dominating mother-in-law, conspiring sisters-in-law may bear resemblance with a certain reality of society but we cannot ignore the changing and shifting patterns of identity of women within household. With education and exposure, the status of women in the average Indian household is surely changing. Education, awareness and consequent economic independence is giving a boost to today's woman.

She is striving to become more confident and is no longer afraid to dream. Today's woman no longer identifies herself with a decked up doll yearning for her man's attention. But many of the daily soaps fail to reflect these changes and remain entrenched in certain deep-rooted notions that are hard to be erased away.

The situation, however, is not abysmal. It can be seen that there's a noticeable shift in the narrative now and we do have some daily soaps celebrating women protagonists for the grit, determination and strength of character rather than their physical assets and attributes. There are soaps on the Indian television that do not hesitate to take up issues typically considered stigmatized. They dwell the storyline on the inner character of the female protagonist rather than their physical assets.

Socially India has come a long way. Surely, even today gender disparity is a matter of concern but things are improving. With education and financial independence, the role of women in society has undergone a sea change. Today's woman is more confident and knows her mind. She's not afraid to question the stereotypes.

The 'liberal' storytellers have captured this sentiment too. We have had highly popular and strong female characters like Anandi (who fought against rigid social malpractices) or Kalyani Devi who represented transformation from a conservative and regressive mother-in-law to a real hero in *Balika Vadhu*. These daily soaps highlight the strength of character of these female protagonists while celebrating their physical imperfections. They undoubtedly are breaking the stereotypes and sending strong messages to the viewers.

Some of these women characters are portrayed to be so comfortable in their skin, in spite of the unjust treatment that they meet not just by the society but also in their family, that it inspires. Be it the short statured Pinky or the dark skinned Purnima or the sexual crime survivor who can not be deterred to approach the authorities on the —social stigma plea of her family -- they all reflect the changing times.

Advertising is one of the major media that affects our daily life consciously and unconsciously and contributes significantly in shaping our mindset in a much broader perspective. In recent years, Indian advertising has witnessed a noticeable transformation in the manner in which women are portrayed. The way women are depicted in advertising has changed to some extent, reflecting the changing role of women in society. Women today are no longer confined within the four walls of the household kitchen. Their aspiration to live their dreams against the odds also taught advertisers to think differently. Many of the marketers wisely utilized this transformation process to launch their product and advertisement strategically. There are two ways in which the advertising content is changing. There are a lot more partnerships and native content is being developed. So it's a positive move in terms of being more reflective of their audience. And this way brands also get closer to the content and tap into issues that matter to the Indian women. But again this change is still far from significant.

There may have been powerful campaigns breaking the stereotypes like Aerial (Share the Load Campaign) or the campaign against domestic violence (Bell Bajao – Breakthrough with Ministry of Women and Child Development) or Dabur Vatika Hair oil (Brave and Beautiful campaign) or Titan Raga 'Her Life Her Choices' Campaign or Tanishq jewellery ad that drives the point that even the oldest and the most traditional members of a family can learn to accept change but they can be counted on fingertips. Today, there are some ad campaigns with curvy models. There are also a few advertisements flaunting and celebrating physical imperfections. However, advertisements objectifying women are far too many. The advertisers still exploit the country's obsession with the fair skin. There are advertisements depicting women nothing more than a commodity. It is high time that the Indian advertiser should hear the warning alarm and understand that incessant exposure to such messages has a negative impact on the viewers and society at large. It also undermines the status of women. How casual



do we often take the female gender in the present times can be understood from the recent instance when so-called brand Hardik Pandya's apparent loose talk on a talk show. At that time, Hardik Pandya was endorsing many brands including Gillette. Gillette as a brand took a stand and removed the cricketer as its brand ambassador for the Indian market. What is appalling is that even in 2020 we continue objectifying women. Imagine in the time of Me Too movement, we have ad campaigns glorifying sexual harassment at work. Most advertisers who can not look at women in a progressive and modern avatar – whether it is a fairness cream ad or a jewellery brand that conveys 'getting married' is what every girl dreams of or a mango drink advertisement that uses a woman celebrity in a seductive manner (Slice) are doing a great disservice to the society.

Cinema is considered the reflection of society. It has always been viewed as a significant point of reference for gaining an insight into the prevailing Indian culture. It has shaped and expressed the changing scenarios of the modern India to an extent that no preceding art form could ever achieve. Hindi cinema has influenced the way in which people perceive various aspects of their own lives. It has evolved with the changing times.

Anurag Basu, in a recent interview to an FM channel said – We are living in the times of good cinema. Past few years have witnessed the Hindi Cinema breaking the stereotypes related to women and the phenomenon of the Indian Woman 'coming-of-age'.

We have had many films highlighting women issues not just pulling off well but also being box office hits. A decade back, a film without a male superstar could never be taken seriously. But today, we can happily boast of films like Kangana Ranaut's Queen, Vidya Balan's Kahaani or Rani Mukherjee's Mardaani and Secret Superstar. The biopics on women sports stars like Mary Kom and Saand ki Aankh produced by Anurag Kashyap have also been box office hits. And then we have films like Dangal and its oft quoted dialogue 'Mhaari Chorriyan ke chorrn se kam sai'. Today the Indian directors do not shy away from making women-centric films which represent the changing times – be it Pink or Panga or a film like Lipstick under My Burqa or Sri Devi's English Vinglish. The Indian film industry surely is not shying away from showcasing the changing times and breaking the stereotypes. Film makers are no longer hesitant to take up often-considered taboo subjects. They are now making women-centric films and often depict a female lead that is not stereotypically beautiful. However, it is pertinent to mention here that despite the progress that Bollywood films have made and the increasing accessibility of these films, objectification of women still continues in most of the Indian movies in the form of item numbers.

#### **4. CONCLUSION**

Media is a potent tool and has the power to influence the mainstream narrative and break stereotypes. The portrayal of women in media has surely improved. The worst excesses have been removed and today the Indian media is taking baby steps towards depicting the portrayal of women and women-centric issues with sensitivity and caution. Change has been initiated but there is still a long way to go. Indian media must wholeheartedly acknowledge and embrace the changing gender roles in the society and also support in efforts to make India an egalitarian society. Media needs to portray women protagonists in a progressive manner.

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# A Study on Measures to Control of NPAs in Banks in Dakshina Kannada District

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## **ABSTRACT**

This paper tries to make an attempt to study of performance and control of NPA's in banks in Dakshina Kannada District. The banking system depends on the NPA's. These directly have an impact on the profitability, liquidity and solvency position of the bank. Higher NPA indicates inefficiency of the bank and lower NPA indicates better performance and management of funds. To increase the performance of the bank, the NPAs need to be reduced and controlled by the banks.

**Keywords: Non-performance assets, control of NPA's.**

## **INTRODUCTION:**

India's financial service industry is dominated by the banking sector that contributes significantly to the revenues of this Industry. To be sure, the industry has generated tremendous employment opportunities for a large section of the populace in India. The back bone of any economy can be best evaluated by the strength and flexibility of its banking structure. In the Indian context, banking is verily the proxy and indeed the cornerstone of the overall economic growth of the country. Non-Performing Assets had been the single largest cause of frustration of the banking sector.

## **Non-Performing Assets :**

A loan (and even a leased asset) that is not paid on or after the due date, and stops generating income for the lending bank is called a Non-Performing Asset (or NPA). In general, any loan installment or EMIs that remain overdue for a period of 90 days or more are put into NPA category.

## **Classification of NPAs**

**The non-performing assets are broadly classified into three categories namely:**

1. Sub-standard Assets- when a loan continues to be unpaid and remains an NPA for a period of up to 12 months.
2. Doubtful Assets- when an asset has remained in the sub-standard category and remains an NPA for more than 12 months.
3. Loss Assets- when the loss has been incurred and the amount has not been written off in half or full.

## **Why NPAs occur?**

Non-performing Assets (NPAs) are widely known as defaults or bad loans. Behind these defaults are causes that result in their increase in the numbers.

## **1. Bad Lending Practices**

When loans are given away by banks without doing a thorough background check of borrowers for their repaying capacity, financial health and intent to repay etc.

## **2. Competition**

When banks compete among themselves and as a result disburse unsecured loans.

## **3. Incremental Component**

When the internal bank management is affected such as the terms of credit, credit policy etc.

## **4. Crisis**

When the revenues and profits are observed lower than the average rate.

## **5. Overhang Components**

When NPAs are an outcome of environmental factors like when the agricultural loans are not repaid due to the slow crop yield or lack of natural facts like rain, water, sunlight etc.

## **Impact of NPAs**

Not just the books of accounts in a bank, NPAs impact a lot more than we think of. Check out the impact of NPAs in detail.

- Depositors get lower returns on their investments and may also lose any uninsured deposits.
- Borrowers have to pay a higher rate of interests on the loans to compensate bad loans.
- Reputation of the bank's shareholders is negatively affected.
- Increased failure due to bad investments and redirection of funds from good to bad projects.
- Liquidity of banks is influenced.

## **The objectives of this paper are:-**

1. To study the impact of NPA
2. To suggest the various measures for control of NPA in banks.

## **Methodology of study**

This primary data and information would be collected from bank managers from few of public and private sector bank in the study area. I have conducted a survey for the purpose of this research paper and my target group was Bank managers from different sectors and the area was Mangalore City. I have collected 35 samples.

## **The primary data has been collected through**

1. Questionnaire Method
2. Personal Interview Method

The Secondary information have been collected through various articles in news papers, magazines, internet etc.

**Research Design:** Descriptive research design is used for the study.

**Data Collection:** Data used in this paper is primary and collected from questionnaire method.

**Data Analysis Tools:** Tools includes Percentage method and Chi square method to control the NPAs better in study area.

### Analysis and Interpretation

Many of the managers came out with more than one suggestion to Control NPAs better. 20% of the managers gave 3 suggestions. 65.7% of them gave at least 2 suggestions, and 82.9% gave at least one suggestion. 17.1% did not respond to this question. The below table provides the details.

### Suggestions to Control NPA's better

Responses	1 <sup>st</sup> Suggestion	2 <sup>nd</sup> Suggestion	3 <sup>rd</sup> Suggestion	Total frequency	Total Percent
Good pre-sanction scrutiny	15	0	0	15	42.9
Effective post sanction Supervision	11	10	0	21	60
Frequent interaction with borrowers	2	6	0	8	22.9
Adherence to KYC( Know your customer) norms	1	0	2	3	8.6
To adequate realizable security	0	2	1	3	8.6
Branches to have adequate manpower for follow up/ supervision of advances	0	2	0	2	5.7
Need based finance	0	2	0	2	5.7
Obtain confidential opinion from other banks where the customer is also maintaining an account	0	1	0	1	2.9
Effective recovery steps	0	0	4	4	11.4
No response	6	12	28	46	--
Total	35	35	35	--	--
Chi Square	20.286	23.600	57.000	---	--
P Value	<.000	<.001	<.000	--	--

From the above table it is evident that 42.9% of the bank managers suggested that good pre sanction scrutiny of loan proposals would help in better control of NPAs. 60% of the bank managers suggested effective post sanction supervision would help in better control of NPAs. 22.9% of the bank managers suggested frequent interaction with borrowers would help in better control of NPAs. 8.6% each of the bank managers suggested i) adherence to KYC (Know Your Customer) norms and ii) taking adequate realizable security would help in better control of NPAs. 5.7% each of the bank managers suggested I) branches supported with adequate manpower for followup/supervision of advances ii) need based finance would help in better control of NPAs. 11.4% of the bank managers suggested taking effective recovery steps would help in better control of NPAs. 2.9% of the bank managers suggested „obtaining confidential opinion“ from other banks where customer is also maintaining an account would help in better control of NPAs. The Chi square test revealed significant difference among these frequencies.

### Findings and Suggestions to Control NPA's better:

Good pre-sanction scrutiny, effective post-sanction supervision and effective recover steps were the measures to control NPA's.

### CONCLUSION:

The Non-Performing Assets is a very important aspect of every banking sector. If NPA is not managed properly, it will have a serious effect on the profitability of the banks and also on the economy of the

country. For solving that, strict policies should be followed by the Government and bankers otherwise it completely damages the profitability of the banker and also it is not good for developing countries like India.

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# Effect of Branching Ratio for Nitrogen Laser System

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## **ABSTRACT**

Transfer pricing is the determination of prices when a company deals with affiliated companies, but transfer pricing is often misused by companies by manipulating the transfer prices as a form of tax avoidance by lowering or increasing the price of product transfers. Another practice of transfer pricing is tunneling incentive in which the companies transfer the assets and profits out of them by manipulating the prices and setting the unreasonable market prices for the personal benefit of the majority shareholders and the burden is borne by the minority shareholders.

The purpose of this study was to determine whether taxation and tunneling incentive influenced the transfer pricing decisions. The population of this research was the companies in the Basic Industrial and Chemical Sector and the Trade, Service and Investment Sector listed on the Indonesia Stock Exchange (IDX) for the period of 2015-2020 and the determination of the sample used a purposive sampling method where the sample was determined with certain criteria. The data analysis method of this research was the statistical method of multiple linear regression analysis by using the IBM Statistical Package for Social Sciences (SPSS) of 26 analysis tool program.

Based on this study, there were 247 companies other than 30 companies met as the sample criteria. According to the research results, known that the tax amount had a significant value of  $0.044 < 0.05$  and the result of the t-test was  $2.025 > 1.97346$ , which meant that the tax amount had a positive influence on the transfer pricing. The significant value of tunneling incentive was  $0,000 < 0.05$  and the result of the t-test was  $4.217 > 1.97346$  which meant that tunneling incentive had a positive influence on the transfer pricing. Based on the result of the F test, it was known that a significant value of  $0,000 < 0.05$  and F test value of  $11,027 > 3.05$ , which meant that the tax amount and tunneling incentive simultaneously had a positive influence on the transfer pricing. And the result of the coefficient determination showed that the taxation and tunneling incentive influenced the transfer pricing by 11.4% and the rest was influenced by other variables.

**Keywords: Tax, Tunneling Incentive, Transfer Pricing**

## **INTRODUCTION**

The development of the globalization era gives a significant impact on the international trade. The progress of the country's economy, the growth in the flow of goods and services globally and the increase in the acquisition of companies among countries have increased the intra company trade, which is the transactions among the related companies form a single entity. Multinational companies take an advantage of the technology, transportation and communication developments to establish subsidiaries, branches and business representatives in various countries to strengthen the strategic alliances for market share, export and import of products in various countries and to improve the efficiency in the management of the group's supply chain. In developing a business, companies need to improve the efficiency and effectiveness in increasing the corporate profits, which is by conducting transactions

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between companies or divisions including transactions of selling goods and services or intangible assets to the related parties across national borders. Multinational companies operate in countries with different tax rates and conditions and this poses risks for the tax administration in each country. This relates to the possibility of tax avoidance practices carried out by multinational companies through transactions among the affiliated companies domiciled in different countries.

Transactions among related parties (one group of companies) are called affiliated transactions. Meanwhile, determining the price in an affiliated transaction is called transfer pricing. The transfer pricing relates to the delivery of goods and / or services between the centers of responsibility in a company. In domestic operations, the transfer pricing system is an activity carried out to maintain the division autonomy, align goals, and evaluate performance, while for the international operations, there are several other factors, they are taxation, government regulations, accumulated funds, rates, joint ventures and foreign exchange controls (Sunardi and Sunyoto , 2015: 201).

Recently, transfer pricing has become an issue in the field of accounting and taxation, in which companies often carry out transfer pricing schemes that are not in accordance with the applicable laws. Transfer pricing is misused by the companies as a form of tax avoidance, they minimize their taxes by allocating the profits to a country imposing a tax rate that benefits them. Tax avoidance practices are also carried out by them by manipulating the transfer price of goods in transactions with the affiliated companies by setting the unreasonable prices. Mispiyanti, (2015) stated that company transactions with related parties are believed to reduce the state tax revenue, this is because the multinational companies will try to shift their tax obligations from the countries imposing high tax rates to the countries applying low tax rates.

In addition, the company's decision to do transfer pricing is tunneling incentive. Hartati and Desmiyawati, (2015) stated that tunneling is a behavior carried out by the majority shareholders by transferring or diverting the assets and profits of the companies for a personal gain, and if there are costs, then the minority shareholders also bear them. If the shareholders have a great control in the company, then the company's action is to carry out the affiliated transactions to transfer the assets or profits of the companies out of them by determining the unreasonable market prices for the benefit of the majority shareholders rather than distributing dividends to the minority shareholders "(Jafri and Mustikasari, 2018).Noviastika et al, (2016) stated that "the companies whose shareholdings are concentrated on one party tend to practice tunneling through transfer pricing transactions and these transactions are carried out through transactions among the affiliated companies".

## **LITERATURE REVIEW and HYPOTHESIS DEVELOPMENT**

### **(Agency Theory)**

Jensen and Meckling (in Yuniasih et al., 2012) stated that the agency relationship is a contract between a principal and an agent to perform services and give the agent an authority to make decisions within the company. According to Scott (2015) agency theory is a relationship or contract between a principal and an agent, in which the principal as the party who employs the agent to carry out the tasks for his interest. Hartati and Desmiyawati, (2015) explained that "agency theory is a theory about the existence of a difference in interests among owners as shareholders, directors and employees which then causes a conflict between personal interests and company interests or what is called as an agency conflict. From the definition above, it can be concluded that agency theory is the relationship between shareholders and



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managers where in this relationship there is a contract in which shareholders authorize managers to manage the business and make decisions for them.

### **Arm's Length Principle**

The Arm's Length Principle is a standard in determining the transfer prices, in this case for tax purposes used in Article 9 of the OECD Model Tax Convention as a situation created or enforced for both parties in a business or financial relationship among the independent companies, then the profit that should be recognized by a company with certain conditions, but because of some reasons, that certain conditions have not been recognized, the meant profit can be included in the company's profit and taxed (OECD Transfer Pricing Guidelines, 2017). The Arm's Length Principle in Indonesia is defined as the principle of fairness and business normality applied in accordance with the Income Tax Law Article 18 paragraph 3 stating that the General Director of Tax has the authority to reassess the income or deduction and determine debt as capital to calculate the Taxable Income of Taxpayers having a special relationship with other taxpayers according to the fairness and business normality which are not affected by a special relationship with the price comparison method among the independent parties, the resale price method, the costplus method, or the other methods.

### **Transfer Pricing**

According to the regulation of the Minister of Finance number 7 / PMK.03 / 2015, transfer pricing is a price determination in business transactions among the affiliated companies. The Organization for Economic Co-operation and Development (OECD) (2009) stated that the transfer pricing is a price in which a company transacts with an affiliated company. When a company transfers intangible property, goods or services to a related company, the charged price is defined as the transfer pricing. Sunardi and Sunyoto (2015: 197) stated that the transfer pricing is the selling price of goods or services sent from a responsibility center to another responsibility center in the company. In addition, Ritonga (2018: 362) stated that transfer pricing is an act of manipulating the price charging of a transaction among the affiliated companies to minimize the overall owed tax burden on the related companies. Quoted from Darussalam (2013: 9) the transfer pricing is any price set by the taxpayer at the time of selling, buying, or sharing resources with the affiliates. Multinational companies use transfer pricing to make sales and transfers of assets and services in their groups. Pohan (2019: 196) stated that transfer pricing is the price calculated for the delivery of goods / services or other intangible assets to the affiliated companies based on the arm's length price principle. From the definition above, the determination of the transfer pricing is the price determined for the transactions of goods, services, or other intangible assets among the companies having a special relationship, the affiliated companies or the divisions within the company based on the principle of fair market prices. According to Pohan (2019: 196) there are two groups of transactions in transfer pricing, they are intra-company and inter-company transfer pricing.

Intra-company transfer pricing is the practice of transfer pricing in transactions among the company divisions, inter-company transfer pricing is the transfer pricing practices carried out by the affiliated companies or the related companies.

### **Tax**

According to Waluyo (2016), tax is the contributions that must be paid by the public to the state according to the general rules by not receiving direct compensation and used to finance the general government expenditures. According to the Law on General Provisions of Taxation number 16 of 2009, tax is an obligatory contribution of the society to the state by an individual or an entity which is

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compelling based on the regulations, by not receiving a direct compensation for the needs of the state and for the greatest welfare of the people.

Quoted in Agoes (2016), Smeets said that tax is an achievement to the government that is owed through general norms and can be enforced without any contra-achievement which is indicated individually and used to finance the government spending. Tax is a definite source of the state funding in carrying out the role of government and contributing to the state (Rawun et al., 2015).

From some of the definitions above, it can be defined that tax is a public contribution (corporation or person) to the state which is obliged (can be forced) to be paid according to the applicable regulations by not receiving a direct compensation but to meet the needs of the state and for the prosperity of the people. But from a business point of view, tax is categorized as the company expenses called as tax burdens, and every company will definitely try to minimize them. In order to reduce them, multinational companies practice tax avoidance by transferring the profits or diverting the assets to the countries having lower or more profitable tax rates. In its practice, companies can also carry out transfer pricing in which they make transactions with the affiliated companies and manipulate the transfer prices with unreasonable market prices. In the multinational business world, each country has different rates and types of taxes, where usually the developed countries will impose the high tax rates and less developed countries will impose the low tax rates (Marfuah and Azizah, 2014).

### **Tunneling Incentive**

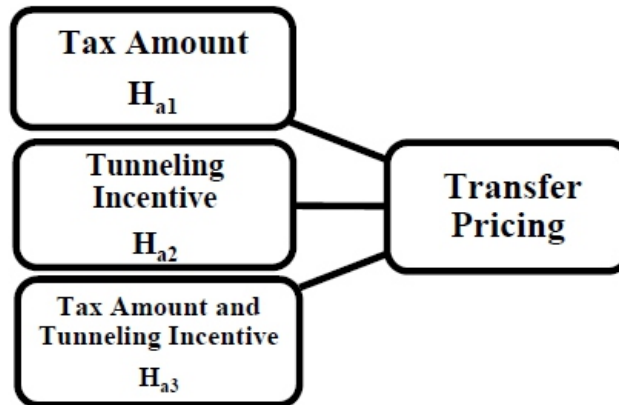
According to Anthony et al. (in Kurniawan et al. 2018) tunneling is the transfer of company assets among the subsidiaries in different countries or among the main companies located in different countries, or from the companies to the majority shareholders to enrich themselves, and the practice of tunneling incentives carried out by the companies is by holding back or not distributing dividends or even by selling the assets of the companies to the majority shareholders. Hartati and Desmiyawati (2015) stated that tunneling incentive is an act of the controlling shareholders who transfer the assets or profits for a personal gain, but the minority shareholders also bear the costs incurred.

Tunneling incentive is an action in decision making or policy by the majority shareholders, and the policy is taken with the aim of personally benefiting without regard to the interests of the majority shareholders which ultimately causes losses to them (Wafiroh and Hapsari, 2015). Tunneling incentive is the actions taken by the majority shareholders by transferring the assets and profits of the companies for their benefit, but when there are costs incurred, the minority will also bear it (Mispiyanti, 2015). Based on the definition above, tunneling incentive can be defined as an action of the majority shareholders who transfers the assets or profits of the companies to obtain the personal benefits and the burden is borne by the minority shareholders. Related party transactions can be used as an opportunistic destination by the majority shareholders to do tunneling where the related party transactions can be in the form of sales or purchases used to transfer the cash or the current assets out of the company through unreasonable pricing in the interests of the majority shareholders. The company also conducts the tunneling for the purpose of minimizing the transaction costs by doing it in a related manner, thus the costs can be reduced. Therefore, it is more economical than making transactions with the unrelated parties.

### **Conceptual Framework and Hypothesis Formulation**

This study examined whether tax and tunneling incentive had an influence on the transfer pricing decisions.

Image 1 Conceptual Framework



Source: Processed Data (2020)

The Relationship between the Tax Amount and the Transfer Pricing Decision The comparison of the number of shareholdings in a company (The shareholders and the majority shareholders) creates agency conflicts in the company. Because the largest shareholders in the company will have more control over the decision making of the company and this can lead to the abuse of shareholder rights in which they will make decisions that can benefit themselves regardless of the minority shareholders. The practice of tunneling incentive is by holding and not distributing dividends and selling the assets of the company to the majority shareholders or to the companies controlled by them at lower prices, thus the tunneling process is easier to do (Kharisma, 2014). The higher the shareholdings by foreigners, the greater the possibility for the companies to transfer their assets to the other countries in order to avoid the tax, and it is easier to do by carrying out transfer pricing (Mutaminah in Yuniasih et al., 2012). Mispiyanti, (2015) stated that tunneling incentive has a significant effect on the transfer pricing decisions, foreign-owned company shares will make sales to the related parties by determining unreasonable transfer prices for the personal interests of the controlling shareholders in a country with lower tax rates than Indonesia. The tunneling incentive variable is proxied by the level of share ownership owned by foreigners of more than 20% of total shares and by looking at the value of assets being misused through related party receivables.

### Hypothesis Development

The formulations of the research hypothesis were as follows:

**Ha1** : The tax amount having a positive influence on Transfer Pricing

**Ho1** : The tax amount having no influence on Transfer Pricing

**Ha2** : Tunneling Incentive having a positive influence on Transfer Pricing decisions

**Ho2** : Tunneling Incentive having no influence on Transfer Pricing

**Ha3** : The tax amount and tunneling incentive having a positive influence on transfer pricing decisions

**Ho3** : The tax amount and Tunneling Incentive having no influence on Transfer Pricing

## RESEARCH METHOD

### Population and Research Sample

The population of this research was the companies in the Basic Industrial and Chemical Sector and the Trade, Service and Investment Sector listed on the Indonesia Stock Exchange (IDX) for the period of 2015-2020. The sample selection technique was done by using the purposive sampling method by determining certain criteria. The details of the samples in the study could be seen in the Table 1.

**Table 1 Sample Determination Criteria**

No	Criteria	Total
1.	Companies listed on the Indonesia Stock Exchange (IDX) in 2015-2020 in the Basic Industrial and Chemical Sector and the Trade, Service and Investment Sector.	247
2.	Companies in the Basic Industrial and Chemical Sector and the Trade, Service and Investment Sector which were not controlled by foreign companies with a shareholding percentage of more than 20% as the controlling shareholders (majority).	(143)
3.	Companies in the Basic Industrial and Chemical Sector and the Trade, Service and Investment Sector that experienced losses during the observation period.	(27)
4.	The companies in the Basic Industrial and Chemical Sector and the Trade, Service and Investment Sector which did not publish the annual reports on the Indonesia Stock Exchange in a row during 2015-2020.	(21)
5.	The financial statements of the sample companies presented in foreign currency.	(26)
	Companies which met the criteria stated	30
	The total of sample companies (30 companies x 6 years from 2015-2020)	180

**Source: Processed Data (2020)**

### Types and Data Collection Techniques

The type of data used in this study was qualitative data in the form of secondary data, which were the annual reports of the companies in the Basic Industrial and Chemical Sector and the Trade, Service and Investment Sector published on the Indonesia Stock Exchange in the period of 2015-2020. The data collection technique used was the documentation method by collecting, recording and reviewing the secondary data information in the form of an overview of the company and an annual report published on the Indonesia Stock Exchange (IDX) accessed through the website [www.idx.co.id](http://www.idx.co.id).

### Operational Definition and Variable Measurement

#### Dependent Variable (Y)

Noviastika et al., (2016) stated that the transfer pricing variable is measured by detecting the sales to the special parties. These sales indicate the transfer pricing. Pricing of sales to the related parties usually overrides the principle of fairness by increasing or decreasing the prices. In this study, transfer pricing was determined by using the value of the related party transaction receivables and the total receivables of the company.

$$\text{Transfer Pricing} = \frac{\text{Receivable from Related Party Transactions}}{\text{Receivable Amount}} \times 100\%$$

### Independent Variable (X)

The independent variables in this study were the tax amount and tunneling incentive

$$\text{Tunneling Incentive} = \frac{\text{Related Party Receivables}}{\text{Total Assets}}$$

### Tax Amount

According to the Law on General Provisions of Taxation number 16 of 2009, tax is an obligatory contribution of the society to the state by an individual or an entity which is compelling based on the regulations, by not receiving a direct compensation for the needs of the state and for the greatest welfare of the people. The tax amount of this research was determined by an indicator with the effective tax rate (ETR), which was a percentage calculation of the tax rates borne by the company.

$$\text{Effective Tax Rate} = \frac{\text{Tax Expense}}{\text{Taxable Profit}}$$

### Tunneling Incentive

Tunneling incentive is an action in decision making or policy by the majority shareholders, and the policy is taken with the aim of personally benefiting without regard to the interests of the minority shareholders which ultimately causes losses to them (Wafiroh and Hapsari, 2015). In this study, the calculation of tunneling incentive was by looking at the value of assets being misused through the related party receivables, thus it could be analyzed by using the transfer pricing behavior (Tang 2016).

## DATA ANALYSIS

The data analysis method of this research was the statistical method of Multiple Linear Regression analysis and used the analysis tool program "IBM Statistical Package for Social Sciences (SPSS) 26".

### The Test Analysis of Descriptive Statistical

In this study, a descriptive statistical test was carried out on the research variables consisting of the dependent variables, they were transfer pricing and the independent variables which were the tax amount and tunneling incentive. The average (mean), standard deviation, maximum and minimum were the descriptive tests used. The results of the descriptive statistical test of all the variables in this study were presented in the following table:

	N	Minimum	Maximum	Mean	Std. Deviation
<b>Tax Amount</b>	180	,01	2295,03	70,1548	213,91667
<b>Tunneling Incentive</b>	180	,0000	5,0923	,163795	,4532567
<b>Transfer Pricing</b>	180	,0000	,9633	,095039	,2170088
<b>Valid N (list wise)</b>	180				

Source: SPSS 26 (2020) Software Output Data

Based on the Table 2, the results of variable measurement regarding descriptive statistics with a sample of 180 companies in the period of 2015-2020 could be explained as follows:

1. The tax amount variable had an average value (mean) of 70.1548 which meant that Companies in the Basic Industrial and Chemical Sector and the Trade, Service and Investment Sector listed on the IDX had 70% average of effective base tax rate. The minimum value of the tax amount variable was 0.01, the maximum value was 2295.03 and the standard deviation was 213.91667.
2. The tunneling incentive variable showed an average value (mean) of 0.163795, meaning that Companies in the Basic Industrial and Chemical Sector and the Trade, Service and Investment Sector listed on the IDX had 16% average of shareholdings by foreign parties. The minimum value for this variable was 0.0000, the maximum value was 5.0923 and the standard deviation was 0.4532567.

### Classical Assumption Test Analysis

The classical assumptions fulfilled were that the data had to be normally distributed.

There was no multicollinearity and heteroscedasticity (Ghozali, 2018).

### Normality test

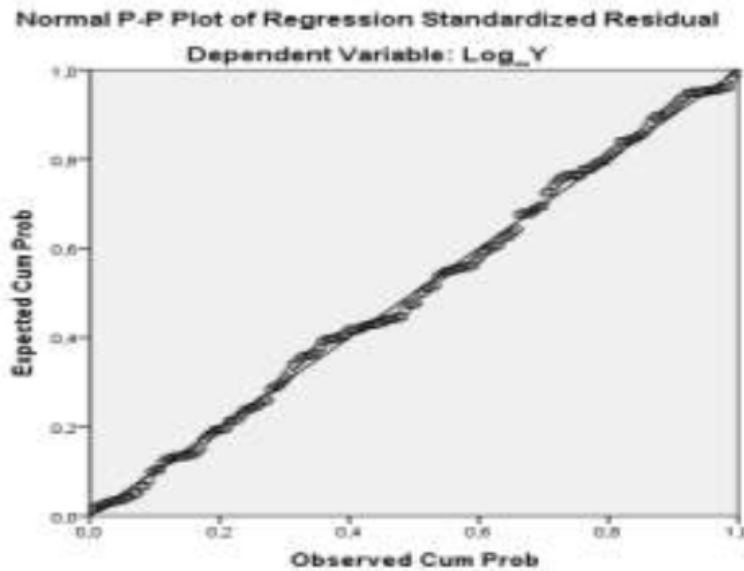
The normality test was carried out to determine whether the dependent variable and the independent variable or both were normally distributed or not in the regression model. In this study, the residual normality test was carried out by using the Kolmogorov-Smirnov (K-S) non-parametric statistical analysis test and statistical analysis test for normal probability plot graphs. The result of the Kolmogorov-Smirnov statistical analysis test could be seen in the Table 3 and the result of the normal probability plot graph analysis test results in the Image 2 below:

**Table 3 One-Sample Kolmogorov-Smirnov Test**

N		Unstandardized Residual 174
Normal Parameters <sup>a,b</sup>	Mean	,0000000
	Std. Deviation	,92047208
Most Extreme Differences	Absolute	,037
	Positive	,037
	Negative	-,035
Test Statistic		,037
Asymp. Sig. (2-tailed)		,200 <sup>c,d</sup>

Source: SPSS 26 (2020) Software Output Data

### Image 2 Normality Test Results (Probability Plot)



Source: SPSS 26 (2020) Software Output Data

Based on the result of the normality test data in the table 3 above, the influence of the tax amount and tunneling incentive on transfer pricing with a significant value of  $0.200 > 0.05$ , thus it could be said that the residual value was normally distributed. In the image 2, it could be seen that the data distribution was scattered around the diagonal line, thus this showed that the regression model fulfilled the normality or residual assumption of the normally distributed model.

### Autocorrelation Test

The regression model is called good if there is no autocorrelation. The test method used the Durbin-Watson test (DW test). The result of the autocorrelation test could be seen in the Table 4:

Table 4 Autocorrelation Test Results

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,127 <sup>a</sup>	,016	,005	,13460	1,915

Source: SPSS 26 (2020) Software Output Data

The result was a DU value  $1.7786 < DW$  value  $1.915 < 4-DU$  value  $2.2214$ , it could be stated that there was no autocorrelation in this regression model, thus it could be said as a good regression model and this data fulfilled the classical assumptions.

### Multicollinearity Test

The multicollinearity test was carried out to test whether there was a correlation between the independent variables which were the tax amount and tunneling incentive.

The Multicollinearity Test Result was showed in the Table 5:

**Table5 Multicollinearity Test Result**

Model	Collinearity Statistics	
	Tolerance	VIF
1 (Constant)		
Tax Amount	1,000	1,000
Tunneling Incentive	1,000	1,000

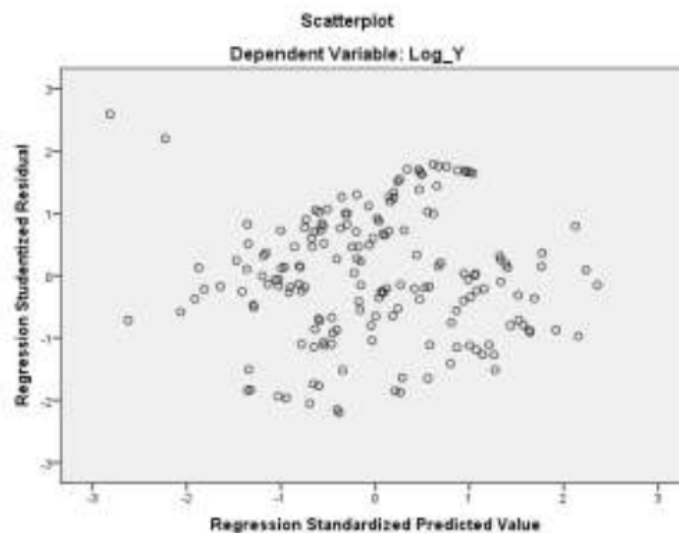
Source: SPSS 26 (2020) Software Output Data

Based on the Table 5, the VIF value of the variable tax amount ( $X_1$ ) = 1,000 < 10.00 and tunneling incentive ( $X_2$ ) = 1,000 < 10.00. Both variables had a VIF value that was smaller than 10, thus it could be concluded that there was no multicollinearity at the data above.

### Heteroscedasticity Test

The regression model can be called good if homoscedasticity or heteroscedasticity does not occur (Ghozali, 2018). In this study, the heteroscedasticity test was carried out by observing a scatterplot chart. The result of the heteroscedasticity test could be seen in image 3:

**Table 3 Heteroscedasticity Test Results**



Source: SPSS 26 (2020) Software Output Data

In the image above, it could be seen that there were unclear patterns and the dots (plot) spread above and below the number 0, thus this data indicated that there was no heteroscedasticity or this data could be called homoscedasticity.



### Multiple Linear Regression Analysis

In this study, multiple linear regression analysis was conducted to examine the influence of the tax amount and tunneling incentive on the transfer pricing decisions. The result of multiple linear regression analysis was showed in the Table 6 below:

**Table 6 Multiple Linear Regression Analysis Result**

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
1 (Constant)	-1,775	,245		-7,243	,000		
Tax Amount	,264	,130	,146	2,025	,044	1,000	1,000
Tunneling Incentive	,296	,070	,304	4,217	,000	1,000	1,000

### SPSS 26 (2020) Software Output Data

Based on the table above, the multiple linear regression equation for this study was as follows:

$$Y = a + b_1X_1 + b_2X_2 + e$$

#### Information:

Y = Transfer pricing

X1 = Tax amount

X2 = Tunneling incentive

a = Constant

b = Regression Coefficient

e = Error

$$Y = -1,775 + 0,264 X_1 + 0,296 X_2 + e$$

#### The explanation of the regression equation model above was as follows:

1. The regression constant was -1,775 which indicated that if the value of the independent variable consisting of the tax amount (X1) and tunneling incentive (X2) was 0, then the amount of the dependent variable (transfer pricing) was - 1,775.
2. The influence of X1 on Y, the variable value of the tax amount (X1) was 0.264, this showed that the higher the tax rate, the more likely it was for the company to practice the transfer pricing with the assumption that the other variables were constant.
3. The influence of X2 on Y, the value of the tunneling incentive variable (X2) was 0.296, this showed that the higher the tunneling incentive, the more likely it was for the company to practice the transfer pricing, assuming the other variables were constant.

## Hypothesis Test

### Partial Test (T Test)

The T test was used to measure the level of partially significant influence between the independent variables, which were the amount of tax (X1) and tunneling incentive (X2) on the dependent variable, which was transfer pricing (Y). The t test was as follows:

**Table T Test Result**

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	
	B	Std. Error	Beta			
1	(Constant)	-1,775	,245			
				-7,243	,000	
	Tax Amount	,264	,130	,146	2,025	,044
	Tunneling Incentive	,296	,070	,304	4,217	,000

Source: SPSS 26 (2020) Software Output Data

Based on the Table 7, it was known that the variable X1 tax amount had the significant value of  $0.044 < 0.05$  and the t count value of  $2.025 > t$  table 1.97346, thus  $H_{a1}$  was accepted and  $H_{o1}$  was rejected. And it could be concluded that the tax rate variable partially had a positive effect on the transfer pricing. The X2 tunneling incentive variable had the significant value of  $0.000 < 0.05$  and the t count  $4.217 > t$  table 1.97346, therefore  $H_{a2}$  was accepted and  $H_{o2}$  was rejected. And it could be concluded that the tunneling incentive variable partially had a positive effect on the transfer pricing.

### Simultaneous Test (Test F)

The F test was carried out to measure the level of significant influence simultaneously between the independent variables which included the tax amount (X1) and tunneling incentive (X2) on the dependent variable, which was transfer pricing (Y). The F test was as follows:

**Table 8 The Result of Test F**

Model	Sum of Squares	df	Mean Square	F	Sig.	
1	Regression	18,904	2	9,452	11,027	,000 <sup>b</sup>
	Residual	146,578	171	,857		
	Total	165,482	173			

Source: SPSS 26 (2020) Software Output Data

Based on the table above, it was known that the significant value was  $0.000 < 0.05$  and the value of F count was  $11.027 > F$  table was 3.05, thus  $H_{a3}$  was accepted and  $H_{o3}$  was rejected. Therefore it could be concluded that the two independent variables, (the tax amount and tunneling incentives) simultaneously had a positive effect on the dependent variable which was transfer pricing.

### Multiple Coefficient Determination Test (R<sup>2</sup>)

The test of Coefficient Determination was used to determine the influence percentage of the independent variable simultaneously on the dependent variable. R<sup>2</sup> ranged from 0-1, if the value of R<sup>2</sup> was equal to 0, then there was no influence percentage of the independent variable on the dependent variable or the independent variable did not explain the variation inside it. The result of the Coefficient Determination of R<sup>2</sup> was showed in the following table:

**Table 9 The Result of Multiple Coefficient Determination Test (R<sup>2</sup>)**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,338 <sup>a</sup>	,114	,104	,92584

**Source: SPSS 26 (2020) Software Output Data**

The Result of Multiple Coefficient Determination Test (R<sup>2</sup>) in the table above showed that the R square was 11.4%. This result showed that the ups and downs of transfer pricing were influenced by the tax amount and tunneling incentive of 11.4%, while the remaining 88.6% was influenced by other variables than the variables studied.

## DISCUSSION

The results of this study showed that the tax amount had a significant value of  $0.044 < 0.05$  and the T test result of  $2.025 > 1.97346$ . This indicated that the tax amount had a positive effect on the transfer pricing. Tunneling incentive had a significant value of  $0.000 < 0.05$  and the test result was  $4.217 > 1.97346$ , which meant that tunneling incentive had a positive effect on the transfer pricing. Thus,  $H_{a1}$  and  $H_{a2}$  were accepted, while  $H_{o1}$  and  $H_{o2}$  were rejected. Based on the F test result, it was known that the significant value was  $0.000 < 0.05$  and the F test value was  $11.027 > 3.05$ , thus  $H_{a3}$  was accepted and  $H_{o3}$  was rejected. This showed that the tax amount and tunneling incentive simultaneously had a positive effect on the transfer pricing. And the result of the coefficient determination showed that the tax amount and tunneling incentive influenced the transfer pricing by 11.4% and the rest was influenced by other variables.

### The Influence of Tax Amount on Transfer Pricing Decisions

Based on the result of the partial test in the table 7 which showed that the tax amount had a positive effect on the transfer pricing, this meant that the higher the tax amount borne by the company, then the companies in the Basic Industrial and Chemical Sector and the Trade, Service and Investment Sector listed on the Indonesia Stock Exchange to carry out transfer pricing with related parties in order to minimize the burden will increase. The result of this study supported the research conducted by Deanti, (2017); Kurniawan et al. (2018); and Wafiroh and Hapsari, (2015) who found that the tax amount had a positive effect on transfer pricing decisions. Where the transfer pricing transactions were carried out

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with companies having special relationship which were outside the state boundaries that had low tax rates with the aim of transferring their assets, thus the tax burden borne would be smaller. To minimize the tax burden borne, the company would definitely try to report a small profit in its financial statements by carrying out transfer pricing, which was by transacting with the affiliated companies or with the related parties in other countries by manipulating transfer prices or by determining unreasonable prices. And the higher the tax amount borne by the companies, then the more likely it was for them to carry out the transfer pricing.

### **The Influence of Tunneling Incentive on Transfer Pricing**

Based on the result of the partial test in the Table 7 showing that tunneling incentive had a positive effect on transfer pricing, then it meant that the increasing tunneling incentive would increase the decision of companies in the Basic Industrial and Chemical Sector and the Trade, Service and Investment Sector listed on the Indonesia Stock Exchange to carry out transfer pricing with the related parties. The result of this test supported the research conducted by Kurniawan et al., (2018); Marfuah and Azizah, (2014); Mispianiti, (2015); Wafiroh and Hapsari, (2015) who found that tunneling incentive had a positive effect on transfer pricing, in which the company did tunneling with the company selling products at a lower price than the market price to the related parties (Marfuah and Azizah, 2014). If the largest shareholding or majority shareholders were owned by foreigners, it could trigger the possibility for them to conduct tunneling incentive by transferring the assets and profits of the companies by transacting with the affiliated companies by manipulating the prices and determining the unreasonable market prices to seek the majority's personal gain and the burden is borne by the minority shareholders.

### **The Influence of Tax Amount and Tunneling Incentive on Transfer Pricing Decisions**

The simultaneous test result in the Table 8 showed that the tax amount and tunneling incentive simultaneously had a positive effect on the transfer pricing. This showed that if the tax amount and tunneling incentive increased, then the decision of companies in the Basic Industrial and Chemical Sector and the Trade, Service and Investment Sector listed on the Indonesia Stock Exchange to carry out transfer pricing would also increase in which if the shareholding owned by the foreign parties was getting bigger, then it would encourage the companies to move the assets or profits out of the them to another country or to a related party by determining an unreasonable market price in order to minimize the tax burden. The independent variable affected the dependent variable by 11.4%, while the rest was influenced by variables other than the variables studied.

## **CONCLUSION**

Based on the research conducted with regression analysis and the discussion results, the conclusions which could be drawn were as follows:

1. Tax had a positive influence on the transfer pricing decisions for the companies in the Basic Industrial and Chemical Sector and the Trade, Service and Investment Sector listed on the Indonesia Stock Exchange (IDX) in the period of 2015-2020. They carried out transfer pricing to the affiliated companies or to the related parties located in different countries by manipulating the transfer prices and by determining the unreasonable market prices, thus they could minimize the tax to be paid, and the higher the tax amount borne by them, then the more it would trigger them to perform the transfer pricing.
2. Tunneling incentive had a positive influence on the transfer pricing decisions for the companies in the Basic Industrial and Chemical Sector and the Trade, Service and Investment Sector listed on the Indonesia Stock Exchange (IDX) in the period of 2015-2020. The

majority shareholding owned by foreign parties could trigger the controlling or the majority shareholders to conduct tunneling incentive, which was by transferring the assets and profits of the companies to a related party or an affiliated company to seek the personal benefit for them.

3. The tax amount and tunneling incentive simultaneously had a positive influence on the transfer pricing decisions in the Basic Industrial and Chemical Sector and the Trade, Service and Investment Sector listed on the Indonesia Stock Exchange. When the tax amount and tunneling incentive increased, the decision for companies to carry out transfer pricing would increase. In the hypothesis test, the variable of the tax amount and tunneling incentive had an effect of 11.4% on the transfer pricing variable, while the remaining 88.6% was influenced by other variables.

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## **REGULATIONS**

Regulation of the Minister of Finance of the Republic of Indonesia number 7/PMK.03/2015 concerning Procedures for Establishing and Implementing an Advance Pricing Agreement. Jakarta. Regulation of the Republic of Indonesia number 16 of 2009 concerning Stipulation of Government, Regulation of Law number 5 of 2008 concerning the Fourth Amendment of Law and Regulation number 6 of 1983 concerning General Provisions and Tax Procedures into Law.

# Teaching AI in Knitwear Education, with Reference to the Application of Artificial Neural Networks (ANN)

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## **ABSTRACT**

With the rapid advancements in knitwear and knitting technology, there is an increasing scope of teaching advanced concepts like Artificial Intelligence (AI) in the Knitwear curriculum. The scope of technical textiles has also increased and so has the need to develop more and more precise fabrics that meet certain parameters and needs thereby. This has resulted in the need to improve the fabric design procedures so that the final products conform to certain technical properties, like thermal conductivity, bursting strength, etc. The performance of the knitted fabrics is desired to be predictable right from the design phase, and this can be a very relevant and useful input for the future knitwear designers and technologists. Hence, knit fabric design is focusing on the control of its parameters, so that the requirements of the end use like sensory comfort, pilling control, handle, strength, etc. can be met. Since most of these parameters don't have a linear mathematical link with the properties as such, hence there has been an increasing need and use of Artificial Intelligence tools, especially the Artificial Neural Networks (ANN), so as to estimate, predict and classify various knitted fabric properties. Hence, this paper mainly reviews and talks about the various applications of ANN in knits, so that they may be incorporated into the Knitwear curriculum in the near future.

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**Keywords: Knitwear, Education, AI, Artificial Neural Networks, Knitted fabrics, Future**

## **INTRODUCTION :**

With the increasing use of knits in various categories of products, the yarn and fabric structure, appearance and the physical properties affecting its final performance are getting more and more crucial. However, the knitted structures are very complex in nature. It's not just the fabric structure that matters but also the fibre and the yarn, including various related parameters of the same. By addressing such concerns for the future of Knitwear industry, it becomes important to discuss the possibility of teaching advanced concepts like AI in the curriculum of knitwear design. If students are equipped with the knowledge and application of such concepts in knits, they can be more future ready for the industry challenges.

The performance of the knitted fabrics depends not only on the structural complexity, as well as from various parameters of the materials themselves, which present a non-linear relationship. This double non-linearity of the knitted fabrics increases the difficulty in the fabric design and manufacturing processes. The complex structure and the complexities introduced by the fibres and yarns do not allow the use of conventional mathematical models for fabric design.

As the current inputs in Knitwear education don't delve into such a scenario, there is a need to incorporate an increasing use of alternative computational models that aim at the prediction of the properties and the performance of the knitted fabrics. Various computational models have been used in

order to represent the fabrics and to predict their final properties. In case of classification problems, Artificial Neural Networks (ANNs) have proved to be a very efficient tool for an efficient solution. Applications of ANNs in the textile field for classification as well as in the prediction of properties and optimization problems (Chattopadhyay & Guha, 2004) have proved to be very effective. The applications of the ANNs in the fabric classification and prediction problems have been tested effectively in the fields of fibres, yarns and fabrics as well as colour, wet processing and clothing.

### **Artificial Neural Networks :**

Artificial Neural Networks (ANNs) are algorithmic structures derived from a simplified concept of the human brain structure (Vassiliadis et al., 2010). They belong to the Soft Computing family of methods, along with fuzzy logic / fuzzy control algorithms and genetic algorithms, (Zadeh, 1994). They all share an iterative, non- linear search for optimal or suboptimal solutions to a given problem, without the presupposition of a model of any type for the underlying system or process, (Keeler, 1992). Various different ANN types have already been successfully employed in a wide variety of application fields, (Haykin, 1998). Major ANN functionalities are :

**i. Function approximation:** this functionality is exploited in system input-output modelling and prediction, and

**ii. Classification:** this functionality is exploited in pattern recognition / classification problems, (Lippman, 1987).

- In their capacity as function approximators, ANNs have long been studied as to the required properties of the target function as well as to the structure of the ANN, in order to guarantee convergence of the – typically iterative – approximation algorithm. The first brain-inspired ANN structure was proposed by McCulloch and Pitts in 1943, along with a proof that it could approximate any deterministic function, (Hertz et. al., 1991). In light of the Cybenko theorem, (Cybenko, 1989), ANNs are recognised today as ‘universal approximators’, i.e. they can approximate arbitrarily closely any function on a compact subset of  $R^n$ , under certain general assumptions on the function. The property was proved for a specific ANN structure (the standard multilayer feedforward network with a single hidden layer that contains a finite number of hidden neurons, with a sigmoid activation function and a linear output layer). Similar results exist for arbitrary activation functions, (Hornik, 1989) and other ANN structures, as well, (e.g., Lin, 1994). A common prerequisite for the ANN to operate as approximator is the linearity of its output node(s).

In a textiles context, the function approximation capacity of ANNs is of great practical interest because a variety of quantities that characterise yarns and/or fabrics depend on (i.e., are functions of) the yarn or fabric consistency, structure and weaving characteristics. Air permeability of a woven fabric, for example, depends on such parameters as warp and weft yarn density and mass per unit area. These dependencies do not always lend themselves to accurate description by an analytic mathematical function; yet, the ability to estimate or predict the value of such a quantity of interest given the yarn or fabric parameters – before actually constructing the yarn or fabricating the fabric – is highly desirable in the textiles design and production phases. Research has turned to ANNs for estimation and prediction tasks in various textile applications, (Stylios & Parsons-Moore, 1993), (Stylios & Sotomi, 1996), (Ertugul & Ucar, 2000), (Majumdar, 2004), (Lin, 2007), (Bhattacharjee & Kothari, 2007), (Gurumurthy, 2007), (Guruprasad & Behera, 2010).



• In their capacity as classifiers, on the other hand, ANNs have found extensive and successful application in virtually all pattern recognition tasks, including 1-D and 2-D signal (image) processing applications, clustering, etc. In such problems, unknown input data are classified as belonging to one of a finite number of known classes or categories. ANN structures with an output layer of nodes (neurons) of the 'competitive' type are suitable for classification tasks. Individual binary outputs of the output layer nodes are vectorised in order to enumerate the class where incoming data belong, in typical classification problems. Single and multiple-layer perceptrons, self-organising maps and other types of ANN structures serve as classifiers. Among them, of practical interest are networks that compute probabilities that a given input belongs to one of the considered classes, rather than deterministic outputs. They can thus substitute multi expert decision algorithms, such as majority-voting, etc. Probabilities can subsequently be handled in a variety of ways to obtain final answers in the output. The classification capacity of ANNs in a textiles context finds extended use in classification of yarn or fabric types or other visual properties, such as color, defects, weaving / knitting pattern, percentage consistency in various materials and the like, (Guruprasad & Behera, 2010). These tasks are affordable in time and equipment investment thanks to the recent technological advances (a) in image capturing equipment of high quality and very low cost and (b) in hardware processors of increased processing power that allow for real or quasi-real time applications.

#### **ANN applications in the textile field :**

The applications of ANNs in the textile engineering field have become more and more popular since the 1990's. Eventually, it was shown that they can effectively address complex engineering problems. Many researchers have used ANNs in the case of a multi parameter and non-linear situation, in the absence of a straightforward analytical solution. Following paragraphs talk about various such applications of ANN in knits, which may be useful in enhancing the knitwear education inputs to a new level, for the future needs of the industry.

The properties of knitted fabrics need to meet the user requirements; hence, the prediction of their properties and the fabric performance is very important. The fabrics are complex structures, if their micro mechanical structure is considered. The structural complexity in along with the yarn complexity do not usually allow the development of conventional analytical tools for supporting the design phase, as in the the case of other engineering fields such as mechanical, electrical, etc. Therefore, a lot of effort has been given towards the development of computational models for the prediction of the behaviour of fabrics (Basu et al., 2002).

The inspection of the fabrics for faults detection is one of the crucial operations in the industry, usually carried out by skilled operators. Many efforts have been made in order to perform the inspection automatically. Hence, the task of automated defects detection is popular and many research teams have shown their interest on it, while many of them have used ANNs to perform the fault detection task, (Tsai et al., 1995; Sette & Bullard, 1996; Tilocca et al., 2002, Kumar, 2003). Using the same principles, stitch inspection can be achieved (Yuen et al., 2009).

Drapability is one of the the most complex physical property of a fabric and it is essential for many uses in fashion. The prediction of the drape has been made using ANNs (Fan et al., 2006). In parallel the engineering of the drapability of the fabrics became possible though a predictive tool (Stylios & Powel, 2003). Fabric hand is a property that combines the physical properties of a fabric with the sensory perception of the fabric by the humans when it is touched. Some complex systematic approaches for the

definition of the fabric hand, which include the full set of the low stress physical properties of the fabrics. Obviously, the prediction of the fabric hand is equivalent to the prediction of the low stress physical properties of fabrics. It is a complex, highly non-linear problem and therefore an early target for the application of ANNs (Youssefi & Faez, 1999).

The data from the FAST system were used to approach the hand of the fabrics (Sang- Song & Tsung-Huang, 2007), while fuzzy logic was combined with ANN for the evaluation of the fabric hand (Park et al., 2000). ANNs and fuzzy logic have been used together in the case of the prediction of the sensory properties of the fabrics, as well (Jequirim et al., 2009). The prediction of the desirable properties of the fabrics is an essential technical requirement. ANNs have been used for the prediction of the tensile strength (Majumdar et al., 2008) and for the initial stress-strain curve of the fabrics (Hadizadeh et al., 2009). The same problem has been solved using an adaptive neuro-fuzzy system (Hadizadeh et al., 2010). The shear stiffness of the worsted fabrics (Chen et al., 2009) and their compression properties have been successfully modelled (Murthyguru, 2005; Gurumurthy, 2007). In general, the prediction of the properties of a fabric enables the support of the design phase, (Behera & Muttagi, 2004), and this can be a very useful tool for the knitwear designers in the filed of fabric/apparel design and development.

The prediction of bursting using ANNs for knitted fabrics (Ertugrul & Ucar, 2000) as well as for woven fabrics (Vassiliadis et al., 2010) has been achieved with satisfactory results. The permeability of the woven fabrics has been modelled using ANNs as well (Tokarska, 2004; Çay et al., 2007). The pilling nature of the fabrics has been predicted (Beltran et al., 2005) and the pilling of the fabrics has been evaluated (Chen & Huang, 2004), while the presence of fuzz fibres has been modeled. Prediction of the spirality of the relaxed knitted fabrics (Murrells et al., 2009) as well as knit global quality (Slah et al., 2006) and subjective assessment of the knit fabrics (Ju & Ryu, 2006) have been implemented. Prediction of the thermal resistance and the thermal conductivity of the textile fabrics has been realised with the help of ANNs (Bhattacharjee & Kothari, 2007; Fayala et al., 2008). Moisture and heat transfer in knitted fabrics has been also studied similarly (Yazdi et al., 2009). Engineering of fabrics used in safety and protection applications is supported by ANNs (Keshavaraj et al., 1995; Ramaiah et al., 2010). Prediction of the fabrics end use is also possible via the same method (Chen et al., 2001). Optimisation of the application of a repellent coating has also been approached by the ANN model (Allan et al., 2002). Such applications can be very handy for the knitwear technologists , especially to think and apply at the knitted fabric stage.

## **ANN in the field of Knits :**

### **A. Bursting strength prediction:**

The bursting strength of knitted fabrics was predicted before manufacturing using intelligent techniques of neural network and neuro-fuzzy approaches in a research ((Ertugrul & Ucar, 2000). Among many parameters that affect fabric bursting strength, fabric weight, yarn breaking strength, and yarn breaking elongation were the input elements used .In this research, both the multi-layer feed-forward neural network and adaptive network based fuzzy inference system, a combination of a radial basis neural network and the Sugeno-Takagi fuzzy system, were analysed. Both systems showed the ability to learn training data successfully, and testing errors were found to be small enough to give an approximate knowledge of the bursting strength of the fabric to be knitted. In another study (Jamshaid et al., 2012) , the aim was to compare the response surface regression and adaptive neuro-fuzzy models for predicting the bursting strength of plain knitted fabrics. The prediction models were based on the experimental data

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comprising yarn tenacity, knitting stitch length and fabric GSM as input variables and fabric bursting strength as output variable. The models quantitatively characterise the non-linear relationship and interactions between the input and output variables exhibiting very good prediction ability and accuracy, with ANFIS model being slightly better in performance than the regression model.

### **B. Apparent Quality of weft knitted fabric**

In a research (Semnani et al., 2005), it was attempted to present a novel definition for apparent quality of weft knitted fabrics with reference to the yarns, using the image analysis method, which are calculated by neural networks. First, standard boards of yarn were analysed using the image analysis method and Artificial Neural Networks. Then, samples of plain, cross-miss and plain pique fabrics and their used yarns were tested for appearance. The results showed that the correlation between apparent quality of knitted fabrics and their yarns was very strong. The ANOVA test confirmed that there was a strong influence of yarn type and fabric structure on fabric apparent quality. Although the yarn type has a strong effect on fabric appearance, the effect of fabric structure on its appearance was not significant.

### **C. Pilling propensity of knitted fabrics**

Fabric pilling is affected by various interacting factors. This study (Beltran et al., 2005) used Artificial Neural Networks to model the multi-linear relationships between fiber, yarn and fabric properties and their effect on the pilling propensity of pure wool knitted fabrics. This tool enabled the user to gauge the expected pilling performance of a fabric from various inputs. It provided a means of improving current products by offering alternative material specification and/or selection. In addition to having the capability to predict pilling performance, the model also allowed for clarification of major fiber, yarn and fabric attributes that affect fabric pilling.

The findings from this study suggested that the prediction of pilling propensity is achievable using an Artificial Neural Network modelling technique. One of the limitations was the limited number of data sets used to train the network, which can be reduced by additional data. Optimisation of network parameter settings and pre-processing should also further improve the accuracy of the predictions. The capacity to predict the propensity of a fabric to pill, the interactions between key parameters could be realised and therefore ultimately controlled to minimise pilling behaviour of the fabric.

### **D. Sensory properties prediction from process and structure parameters of knitted fabrics**

In a study (Jeguirim et al., 2009), talked about competitive market, due to which the textile industrialists intend to propose diversified products according to consumers preference. For this purpose, the integration of sensory attributes in the process parameters proved to be a useful alternative. This study provided fuzzy and neural models for the prediction of sensory properties from production parameters of knitted fabrics. The prediction accuracy of these models was tested using both the root mean square error (RMSE) and mean relative percent error (MRPE). The results revealed the models ability to predict tactile sensory attributes based on the production parameters. The comparison of the prediction performances showed that the neural models are little better than the fuzzy models.

The obtained results revealed that the neural networks and fuzzy logic provide an alternative approach to understanding and predicting tactile sensory properties from Various given parameters of knitted fabrics. The MRPE values were acceptable (<10%) and the RMSE values were lower than the mean variations of experimental values. The neural models were found to be slightly better than the fuzzy models. Therefore, both techniques were presented as a promising tool for engineering industrial

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products design in order to satisfy the specific needs of consumers. Also, minimal number of experiments or learning data and short cycles of product design and product development were sufficient.

### **E. Prediction of Thermal Conductivity**

In a study (Fayala et al., 2008), it was attempted to work on the comfort temperature for an individual or group, by means of thermal conductivity as a physical characteristic of knitted fabric. It depended on many fabric parameters and it was difficult to study the effect of one without changing the others. Also, the non-linear relationship of fabric parameters and thermal conductivity didn't allow for mathematical modelling. So a Neural Network approach was used to predict the thermal conductivity of knitted fabric, as a function of porosity, air permeability, weight and fiber conductivity. Data on thermal conductivity was based on experiments carried out on jersey knitted fabric.

The ANN system was used to predict the thermal conductivity of knitted fabric. Many configurations of ANN were proposed and the optimal configuration was selected. The selected system was found to have four input parameters (yarn conductivity, weight per unit area, porosity and air permeability), one output (fabric thermal conductivity) and with five neurons in one layer. This system was able to predict fabric thermal conductivity with 0.913 as correlation coefficient. This model can be easily applied for industrial purposes to improve the thermal conductivity of knitted fabric.

### **F. Prediction of the total hand value of summer knitted T-shirts**

Not only for fabrics, the ANN models have also been used for knitted apparel performance analysis. (Hasani et al., 2009), in a study, used Weighted Euclidean Distance, for indirect determination of total hand value from the KES system parameters obtained for various summer knitted T-shirts. In this method, the weight of multivariable related to fabric hand were determined from objective measurements without any resource to subjective evaluation. Artificial Neural Network with back propagation learning algorithm and multiple linear regression algorithm have been used to construct predictive models for the determination of total hand value of summer knitted T-shirts based on fabric physical properties measured on the KES system of each sample as input and total hand value predicted by mathematical model as desired output. The predictive power of optimised models is calculated and compared. The results reveal that the Artificial Neural Network model is very effective for predicting the total hand value and has the better performance as compared to Multiple Linear Regression Model.

In this study, the feed forward neural network model with 16-16-1 architecture, i.e. sixteen input unit, sixteen neurons in hidden layer and one output neuron, was found better than the multiple linear regression model for the prediction of total hand value of summer knitted T-shirts based on five primary hand features of KES system, namely firmness, stiffness, fullness, roughness, and crispness, as input parameters. The mean square error (MSE) for predicting the testing data was found to be 0.1170 and 0.2053 for ANN and multiple linear regression models respectively. The results showed the good capability of ANN algorithm to predict total hand value of knitted summer T-shirts.

### **CONCLUSION :**

Hence, attempt has been made to compile and review some of the applications of the Artificial Neural Networks (ANN) methods for the solution of textile problems, with a view to incorporate the same in the future curriculum of knitwear education. Related publications on the field have been reviewed so as to present a picture of the promising potential of Artificial Intelligence, with reference to the ANN's.

Beginning from the the nineties, a continuously increasing number of ANN applications have provided solutions to complex and multivariable textile problems. It can be seen that the textile industry has found ANN as a powerful and efficient tool that can be used for non-linear analysis from fiber to fabric to apparel. For knits, it has proved to be an effective research tool for prediction of various fabric properties , which can lead to intelligent systems for virtual design and optimisation of the fabric properties and resources. It can be seen that ANNs will increase their level and utility of applications in the coming times, so as to solve more and more complex problems in the field of textiles and apparel. Hence, the inclusion of such concepts in the knitwear curriculum can be a promising step for the future knitwear professionals.

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