ISSN: 2072-7542

BUBT Journal

Bangladesh University of Business & Technology

BUBT
Journal

ISSN: 2072-7542

BUBT

Bangladesh University of Business & Technology

Main Road, Rupnagar

Mirpur-2, Dhaka-1216, Bangladesh

BUBT Journal

Volume VIII January – December, 2016
ISSN: 2072-7542

Publisher
Dr. Md. Harun-or-Rashid
Registrar
Bangladesh University of Business & Technology (BUBT)
Rupnagar, Mirpur-2, Dhaka-1216, Bangladesh

Printed By
Real Printing & Advertising
Purana Paltan
Cell: 01920 898783

Cover Design
Wahid Murad Raseel

Price: BDT 200.00
US$ 20.00

BUBT Journal

Bangladesh University of Business & Technology

Editorial Board

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F A C U L T Y O F L A W

Deaths, Archetypes and the Return of the Repressed: Chopin's "The Story of an Hour" and Tagore's "Deliverance"

Md. Reza Hassan Khan

Abstract

"The Story of An Hour" *by Kate Chopin and* "Deliverance" *(Uddhar) by Rabindranath Tagore are two contemporary short stories set apart by two distant cultural and literary traditions, yet having the sameundercurrent of complex psychological manifestationsand the very noticeably similar tragic and ironic endingsas theliterary expression of the female condition in an unchanging world shaped by patriarchal norms and values. This striking similarity raises some serious questions like howthe repressive female situation hastransformedacross cultures in different parts of the world and how the change is recordedin literatures of different languages and cultures in different times.The death of the female protagonist in both the stories and the way these deaths are interpreted by the 'collective unconscious' of the society indicate a kind of universal female distress unchanged throughout history. The paper examines, through Freudian and Jungian psychoanalytic lenses, thismuch unanticipated 'universality' of the repressive female situation in marital relationships as delineated in both the stories. Apart from comparing the two stories as instances of repressive marriages and ironic deaths, this paper aims at bringing out the role of the collective unconscious, rooted in theshared experience of archetypal images of women from myths, in the literary expression ofrepression or sublimation of desires in different times and cultures.*

"The Story of an Hour" is a short story written by Kate Chopin in 1894 and originally published in *Vogue* on December 6, 1894 as "The Dream of an Hour". It was first reprinted in *St. Louis Life* on January 5, 1895 as "The Story of an Hour." On the other hand, Tagore's "Deliverance" (*Uddhar*) was first published in 1900 (*Shrabon* 1307). In relation to their dates of publication, these two stories are contemporary but belong to two very distant cultures and literary traditions. Though they both have a striking similarity, yet it does not seem to provoke much attention from the critics of comparative literature. This paper will discuss

the way both Tagore and Chopin ironize the deaths of the female protagonists and satirize the stereotypical tendencies and values of the patriarchal society associated with the repression in marriage. This paper also aims at bringing out the role of the collective unconscious, rooted in archetypal images of women from myths, in the literary expression of the repression or sublimation of desires in different times, places and cultures.

According to the Norwegian critic Per Seyersted, Kate Chopin "was the first woman writer in her country to accept passion as a legitimate subject for serious, outspoken fiction" (22). Chopin had a traumatic early life. In 1855 her father was killed in a railroad accident before she got married to the wealthy Oscar Chopin and gave birth to five children. The rumor of the accidental death of Mr. Mallard in Chopin's story evidently has a much personal association to her traumatic childhood memories (Koloski). In Tagore's story, the name of the female protagonist is Gauri. In Indian mythology, the word Gauri is an epithet of the good-hearted mother goddess known as Parvati and Uma, the consort of Shiva ("Parvati"). Tagore used the name Gauri in some of his literary creations often associating it with an ill matching husband(Tagore, Das and SahityaAkademi 123-24). As in the poem "Death-Wedding" (Maran Milan) translated by William Radice:

> . . . Death, Death, tears of joy
> Filled Gauri's eyes and the garments at her breast
> Quivered; her left eye fluttered and her heart
> Pounded; her body quailed with thrilled delight
> And her mind ran away with itself, Death, Death;
> Her mother wailed and smote her head at the thought
> Of receiving so wild a groom . . . (Line38-44)

Literature and culture of both the western and the Indian traditions are indebted largely to mythological archetypes that create images of women, set female values, their legitimate goals and aspirations, and most importantly dictate the society the way how it should look at women and their experiences. The archetypal images of women in mythology actually shape up the patriarchal view of the society about women and their social and psychological existenceespeciallywhen marriage is concerned. In the western mythological tradition, we have images of devoted wives, wives

vigorously guarding their chastity, committing suicide for their husbands and lovers etc. which help to form the social archetype, the image of the ‘ideal wife'.

In *Odyssey*, for example, we have Penelope, the wife of Odysseus or Ulysses who waits for twenty years for her husband to return, planning numerous schemes to delay marrying one of the one hundred and eight of her suitors and thus safeguarding her chastity for her husband ("Penelope"). In Euripides’ *Alcestis,* we have the devoted wife of Admetus, who happily took her own life so that her husband’s life could continue (Roche 15-27).We have Antegone, the wife of Peleus who committed suicide when Astydameia, rejected by Peleus, wrote to her that Peleus was going to wed again (Roman and Roman 389). Deianeira was the wife of Heracles who sent him a poisoned robe what she thought to be a love potion that caused his immolation. When she realized what she had mistakenly done, she stabbed herself(Garrison 55).In Virgil’s *Aeneid*, we have Dido, the queen of Carthage who killed herself upon Aeneas' departure from Carthage(Roman and Roman 135-36).

But the Indian tradition will most probably surpass any other mythological tradition where chastity of wives, devotion towards husbands, and religious values dictating the roles and responsibilities of the ‘ideal wife’ in marital relationships are concerned. In *Ramayana*, we have Sita, also known as Janaki, Maithili, or Bhoomija, who after being rescued from her long captivity under Ravana, was forced into exile a second time. Sita was pregnant at that time and she took refuge in the hermitage of Valmiki, where she gave birth to twin sons, named Kusha and Lava. Sita asked for refuge in the arms of her mother Bhūmi. Hearing her prayer to deliver her from an unjust world, the Earth split open, her mother Bhūmi appeared and took her away (“Sita”).

Sati or suttee is an old Hindu funeral custom where a widow immolates herself on her husband's pyre after her husband's death. In that respect we get the concepts of the *Pativrata*, the *Sativrata* and the *Satimata* (“Sati”).The *Pativrata* is the dutiful wife who is devoted to her husband and protective of him. If he dies before her, she vows to burn herself alive which enables her to protect him from dangers in the afterlife. The vow turns her into a *sativrata*before she ascends the funeral pyre with

her husband. After her death on the pyre, the woman is transformed into the image of the *satimata*, a spiritual incarnation of goodness. Typically, the *satimata*is an archetypal image that occurs in the collective unconscious of the society, and works as an example of how to be the ideal*pativrata* ("Sati").

Apart from these, we have *Panchakanya*, a group of iconic heroines of Hindu epics whose names are believed to dispel sin when recited ("Panchakanya"). They are Sita, Ahalya, Draupadi, Kunti, Tara, Mandodariand Anasuya. Ahalya, Tara, Mandodari are from the epic the *Ramayana*; while Draupadi and Kunti are from the *Mahabharata*. The panchakanya are venerated as ideal women and chaste wives in the collective unconscious of the Indian life and literature ("Panchakanya"). We get the image of the goddess Lakshmi, the wife of Vishnu, having archetypal association with wealth, fortune and prosperity ("Lakshmi"). Her name seems to get ever entangled with the archetypal image of the ideal wife. All such mythological archetypes give us the common image of women which fails to recognize the female psychosexual desire and thus rejects the female ego. Apart from the identical tragic and ironic deaths at the end of both the stories discussed in this paper, both the female protagonists deal, in the same manner, with this problem of acknowledging the female psychosexual desires in the patriarchal society and the overwhelming moments of the return of the repressed.

Tagore, for instance in "Deliverance", lets us know that Gauri, the female protagonist of his story comes from 'a traditionally wealthy family' brought up with 'extravagant love' making it very crucial for a psychoanalysis of her later actions and the latent desire to recreate the past. This extravagancy in her early bringing up later creates a 'lack' in her which she tries to attain in her relationship with Paresh, and much to her dismay, eventually fails. On the other hand, Paresh's subconscious mind was burdened with a heap of repressed fears and anxieties as he had to go through a socially unstable situation in the early stage of his career. In classical Freudian psychoanalysis, 'Castration Anxiety' is the fear of emasculation in both the literal and metaphorical sense. This fear of castration plays its role in the very beginning of Paresh's conjugal life for he fails to feel his beautiful young wife as 'fully belonging to him'. He could not attain Gauri till he bettered his economic condition. This

repression of sexual desires and the fear of being socially castrated take the form of a continuous anxiety in him and therefore, 'suspicion was a part of his mental condition'. His psychosocial instability is further intensified by low income, lack of powerful relatives which pushes him off the archetypal position of the powerful husband. According to Freud, the repressed desires and anxieties always find their ways out through our subconscious thoughts and actions. We find the 'return of the repressed' through Paresh's suspicion and his decisive wish to play the archetypal role of the 'powerful and dominating husband'. This complexity of mind is expressed through his act of dismissing the servants one after another without any reason just to deny Gauri's desires or any acknowledgement of her ego which is apparently a threat for him.

Paresh, in fact, suspects a part of him. What Paresh was doing is repressing and 'transferring' his own fear of castration and suspicion over his social capacities to a suspicion over his wife. At a certain point he is 'unable to control himself any more'. It is not the whole world that is in odds against him, rather he was struggling with the repressed fear of incapacity to keep up with the patriarchal norms. This explains why he cannot just divorce Gauri because he needs her and his suspicions over her to validate his own ego. He needed the stereotypical role playing of Gauri as a helpless housewife to complement and to comfort his ego. Actually, they both were posited in opposite relationships where they needed to play stereotypical roles to supplement each other. Gauri was playing the part of the all-enduring-wife, while Paresh was playing the part of the oppressive husband. We see in 'Deliverence', 'the more the exuberant Gouri resented it, the more the husband's behavior became impatient and strange.'

The theme of repression is very crucial in revealing the covert tension within the relationship. According to Indian mythology, the word 'Gauri' is an epithet of the good-hearted mother goddess known as Parvati and Uma, the consort of Shiva("Parvati"). Throughout the whole story Gauri was repressing her desire to be treated as the Indian 'goddess', as her name suggests and as she was treated in her father's house.She was repressing while playing the archetypal role of the 'oppressed housewife'. Even Paresh was repressing the experiences of his traumatic upbringing and social castration all the while "which continued to eat into his heart like a secret wound." The upbringing of Gauri in her

family as a 'proud repressed woman' who uses the norms of patriarchy as a means for a masochistic pleasure in playing stereotypical role of the 'oppressed wife', became 'furious like a wounded lioness' at this insult. This situation can also be viewed from a different angle. It is possible that the suspicion and jealousy in Paresh was deriving from his inability to have a castrated image of Gauri, as Laura Mulvey writes:

> The paradox of phallocentrism in all its manifestations is that it depends on the image of the castrated woman to give order and meaning to its world. An idea of woman stands as lynch pin to the system: it is her lack that produces the phallus as a symbolic presence, it is her desire to make good the lack that the phallus signifies (14).

This inability along with his early economic failure created a fear of castration in Paresh himself and therefore his repressed fear and anxiety was expressed through the pervert jealousy. This jealousy was further intensified by Gauri who 'bruised him with her silent scorns and her oblique looks'.

In sublimation, according to Volney Gay, socially unacceptable impulses or idealizations are unconsciously transformed into socially acceptable actions or behavior and the repressed sexual desires or fears may channel themselves through extreme passion for art or religion (55). In Gauri's case, her repressed desire and sexuality found ventilation through her 'unprecedented interest' into religion when "deprived of conjugal bliss, the childless young woman turned her mind to religion". Accepting Paramananda Swami, the young unmarried priest, as her guru was also suggestive of the repressed sexual desires. As Tagore puts it, "all the wasted love and affection of her woman's heart morphing into devotion were beloved at the feel of her spiritual teacher." We can very well take this as evidence of the sublimation of her unfulfilled and repressed sexual desires. Paresh could not say anything against the priest openly, still the social image of Paramananda did not help Paresh not to feel threatened sexually. Rather, the presence of a young, unmarried male Guru added up to his castration anxiety. Therefore, the relationship between Paramananda and Gauri sexually threatened Paresh. The question that was coiling up in his mind like a snake and came out as "can you swear that you are not in love with that hypocritical priest?" was just an

instance of that continuous sexual threat and castration anxiety he had been going through.

The signs of the return of the repressed is evident in Gauri's response and reply to that question. She 'sprang up like a snake that had been trampled on, and feigning arrogance to spite her husband, said in a chocked voice "Yes I love him! Do what you can!" The threatened sexual incapacity of Paresh found quick association with his repressed fear of castration and results in his trying to win over the situation applying the force of the archetypal husband. He immediately 'bolted the doors, locked her inside and, left for the court house.' Gauri eventually managed to leave the house and reached to Paramananda. The signs of sublimation of her repressed sexual desires became clear when she chose Paramananda instead of her family members who could have been a rescue for her, and when she paid"I wish to dedicate my life the sacred task of serving you."

The repressed sexual desire of the young, unmarried Guru found a way of unraveling itself in the supplication of his 'young, beautiful disciple', and in his case 'the snapped thread of the readings of that day could not be picked up and restrung ever again'. Paramananda was well aware of it but he was afraid of acknowledging it as 'he felt it appropriate for him to leave the town at once.' For a while, the struggle between his superego and id is evident, but he had no other way but to be driven by his unconscious libidinal desire. But to save him from the pangs of the conscience or the superego, he disguised it with the sublimated thought of 'delivering' his disciple. Gauri hid Paramananda's letter 'in the folds of her hair'. This action is further suggestive of the sublimated repressed sexual desire associated with the which she had been 'worn as a jewel in her crown.'The moment Gauri found Paresh dead, with Paramananda's letter in his hand, her conscience immediately acknowledged the guilt complex and destroyed the imaginary, sublimated status of Paramananda in her mind. From that very moment the collective unconscious gathered momentum. She lost her stereotypical image of the 'oppressed wife' and committed suicide. The irony associated with the death of Gauri immediately turned into a satire towards the archetypal mindset and behaviour of the patriarchal society which cannot but think the death of Gauri to be a result of her overwhelming love for her husband.

In “The Story of An Hour” also, the society is unaware of or rather does not want to acknowledge the repressive relationship of the husband and the wife, rather it reaches a conclusion suiting the archetypal mindset of the patriarchal society, the values of which are deeply rooted in the collective unconscious of the society. Reading “The Story of an Hour” psychoanalytically reveals this collective unconscious which is associated with the archetypal image of the ideal wife in the institution of marriage in a patriarchal society. Unlike Gauri, a proud, intelligent, goddess image in Tagore’s story, we get a rather grim image of Louise or Mrs. Mallard, a common housewife, with signs of obvious repressions both in her face and attitude. As Chopin introduces her to us ‘She was young, with a fair, calm face, whose lines bespoke repression and even a certain strength.’ We also come to know about the condition of her heart for which “great care was taken to break to her as gently as possible the news of her husband’s death.” The heart condition and the repressive life that she lives are promptly identified by the reader, maybe it was the author’s design as well, but we can surely notice how repressions in marital life reduced her to a mere ‘non-significant other’. The story first introduces her as Mrs. Mallard and after quite a while she is mentioned by her name Louise, which indicates the writer’s design to focus on the marginalization of her identity in the repressive relationship.

The way Mrs. Mallard reacts and the way her sister behaves reveals that they are under compulsion of the superego, the socially accepted concept of how a woman should behave when she hears about her husband’s death and how a person should behave when she is giving condolence. The idea that Mrs. Mallard has become free, or at least a part of her becomes aware that she has become free as soon as she hears the news, can never be acknowledged in the eye of the superego as it would not be socially accepted. Mrs. Mallard immediately recognizes this traditional value of the society and readily accepts the stereotypical behavior of a woman who has just got the news of her husband’s demise. In fact, no other behavior would be acceptable in that circumstance. Instead of reacting in paralyzed shock as “many women would’ve” done so, Mrs. Mallard “wept at once, with sudden, wild abandonment, in her sister’s arms.” Actually, Mrs. Mallard reacted as she ‘should have’ reacted in the eyes of the society, even before she recognized her true feeling about the situation. She was not shocked, because a part of her

subconscious wanted this to happen and it was, to some extent, psychologically ready for such a situation. At the same time, she was showing the early signs of the return of the repressed 'when the storm of grief had spent itself' she moves to the other room alone.

As Gauri was trying to recreate the very Indian archetypal 'oppressed wife' image, Mrs. Mallard was also role playing the 'Ideal wife' in both her actions and thoughts, and act according to the norms of the 'collective unconscious' or what the famous Jungian analyst Lionel Corbett argues to be the "autonomous psyche" or "objective psyche". This autonomous psyche dictates their actions and behaviors first, but with time the return of the repressed is far more powerful to wash away the guises of the superego.Chopin seems to use the 'open window' in Luise's room as a symbol of the gateway to the unconscious. 'The comfortable, roomy armchair' reminds us the famous 'couch' of Sigmund Freud used for clinical psychoanalysis. The physical exhaustion and the comfort of the armchair together recreate a classic scene of psychoanalysis and the 'things' that Luise sees through her gateway to the unconscious are also fragments of her repressed desires, the 'open squire', 'new spring life', 'the delicious breath of rain', 'the notes of a distant song' that 'reached her faintly', 'countless sparrows twittering' etc all are faded, distant signs of repression delved deep into the subconscious. The 'patches of the blue sky showing here and there through the clouds' are also symbols of the repression in Louise's life. The clouds are the repressive superego which hides the libido, the assertion of the female psyche, metaphorically, the patches of the blue sky. Chopin shows the return of the repressed symbolically and the physical reaction of it when "a sob came up into her throat and shook her" as 'a child sobs in dreams'. She indicates to the unconscious nature of the feeling, relating it to a dream, that Luise has been controlled by the subconscious repression and their return from the realm of the unconscious.

The theme of repression is further intensified in the physical description of Luise. Chopin seems to put her youth in contrast to her repressed married life as "she was young, with a fair, calm face, whose lines bespoke repressions and even a certain strength". Later during the returning moment of the repression Chopin tries to portray Louise's compulsive attitudes. The compulsive forces on the repressed desires and

fears create the physical response as a 'dull stare in her eyes' whose gaze was 'fixed way off yonder', and this compulsive focus is on 'one of those patterns of the blue sky', the symbol of the repressive superego. The repressed fear and desire came to her as a suspended climax and she was "waiting for it, fearfully". She did not know what it was, "too subtle and elusive of name", further intensifying its subconscious nature. And the return was through a series of sensuous images, through the sounds, the scents, the color, creeping out of the sky like an insidious monster which was approaching to possess her and which she was striving to beat back with her will. The fight against the recognition of the repressed fears was actually to save herself from the guilt complex, a struggle between the repressions and the self defense mechanism of her subconscious. The moment of the release of the repressed fear, the moment of recognition and acknowledgement of the repressed desires create physical responses in her. The "vacant stare" and the "look of terror" went away from her eyes, the pulses "beat fast" and "the coursing blood warmed and relaxed every inch of her body".

Chopin's representation of the repressive role of marriage is stronger than love. The unfulfilled desires are stronger than the repressive loyalty and subordination that the repressive institution of marriage requires. She knows she loved her husband 'sometimes', and will again be sad remembering the tender love between them, still she immediately recognizes the much stronger narcissistic desire to fulfill her own desires. Therefore, through the dark cloud of her sorrows for her dead husband, she focuses on the patches of the blue sky, the long procession of years to come that would belong to her absolutely. And her acknowledgement of this desire is expressed through her physical responses when she "opened and spread her arms out to them in welcome".

Chopin's own view of her repressive role in marriage is evident in the comments about Mrs. Mallard's situation. She portrays marriage as a repressive institution and as 'blind persistence with which men and women believe they have a right to impose a private will upon a fellow creature', but the guilt complex of the superego is always there which makes this moment of illumination to seem no less than as a crime. The acknowledgement of libidinal forces, and its compulsive strength over repressive concepts with marriage and love is expressed when she comments "what could love, the unsolved mystery, count for in the face of

this possession of self-assertion which she suddenly recognized as the strongest impulse of her being!"

Louise was actually enjoying the newly found freedom, the acknowledgement of her female psyche, free from the repressions of marital life, when she was forced to come out of the room, from the window, her gateway to the unconscious where "she was drinking in a very elixir of life". But the 'feverish triumph in her eyes' and her carrying herself 'unwittingly like a goddess of victory' show her suppression of the guilt complex aroused by the super ego with the uncontrollable power of the return and acknowledgement of the repressed desires of the libido.

When Mr. Mallard entered into the room using the 'latch key', the phallic symbol that opens the door to the patriarchal dominance, it shatters the newly found freedom of Louise. Her death, like Gauri's death in "Deliverance", is ironically interpreted by the collective unconscious of the patriarchal society as the incapacity to stand the overwhelming "joy" to see her husband back. The collective unconscious of the society acknowledges it as "the joy that kills" and fulfills its need to uphold the archetypal "ideal wife" image.

Both Gauri and Louise have many uncommon traits, but in both the stories, it is the repression associated with marriage, the return of the repressed desires, a moment or opportunity to release their desires or to sublimate and finally, a compulsive acceptance of the social patriarchal norms resulting in tragic and ironic deaths that weave them together. The way their deaths are interpreted reveals the collective unconscious of the society with an unyielding censure of the acknowledgement of the female psychosexuality, and a compulsive unconscious desire to uphold the archetype they created through the mythological and cultural transmission. But the way both Tagore and Chopin inflict irony to the deaths also reveals the satire and rejection of the stereotypical tendencies and archetypal values of the society associated with phallocentric and the repressive propensities of marriage.

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Customer Satisfaction on Some Selected Dhaka Museums: An Empirical Study on Their Services in the Perspective of 'Flower of Service' Model

Monirul Hasan Masum
Muhammad Ruhul Amin

Abstract

Roles of museums are inevitable to collect, safeguard and to study the different historical events which play an important role in the society. But museum management is really a matter of question now a day to meet up the demands of the customer to satisfy them and to protect their identity. This study explores the levels of customer satisfaction on museums in Dhaka City in the perspective of 'Flower of Service' model and it attempts to understand the response of 150 customers (museum visitors) with a structured questionnaire. Flower of service model is one of the established measurements of services facilities of any service organizations. This model has a view of flower with eight facilitating and enhancing services. The core- service stays at the core of the flower and the surrounding eight petals represent the services provided by the organization. This study finds that the museums are facilitating the core services which are moderate but are reluctant about the enhancement services and that is why in most of the cases customers are either neutral or state the disagreement about those services.

Keywords: Museum, Museum Marketing, Supplementary Service, Customer Satisfaction, Flower of Services.

1. Introduction

The role of museum is inevitable to collect, safeguard and study different historical events which play important role in the society. But museum management is really a matter of question now a days to meet up the demands of the customer to satisfy them and to protect the identity of the museums in terms of providing sufficient and pertinent information to the visitors, consulting with researchers, providing other facilitating services like order taking, billing and payment. There are some other dynamic enhancing services which should also be provided by the museum management like consultations with the researchers, hospitality,

safekeeping and any exceptions better than the competitors. Modern managers of the museum are trying to understand and enfold the need to attract visitors. They are liable and responsible to play the key role in education, relaxation, community structure and attracting visitors.

Flower of service model is one of the established measurements of service facilities of any Service organizations. This model has the view of a flower with eight facilitating and enhancing services. The core service stays at the core of the flower and the surrounding eight petals represent the services provided by the organization. Museums are one of the most popular types of non profitable service organizations. That is why majority of the museums are owned and controlled by relative ministry. This study typically attempts to design a flower of service model for the museums in Bangladesh. For this purpose five selected museums from Dhaka city were taken to generate the statistical data from the respondents and finally to design a flower of service on the basis of findings. The findings will generate a clear picture about the current situation of providing services by the museums in Bangladesh and customer satisfaction about it. And this study will be helpful for any further study related to museums or any other service organization.

1.2 Objectives of the Study

The general objective of this study is to identify the level of customer satisfaction on the selected museums of Dhaka city in the perspective of 'Flower of Service' model.

The specific objectives of this study are as follows:

- To identify the core and different supplementary services offered by museums in Bangladesh.
- To design a typical flower of service model for the museums in Bangladesh.
- To analyze the present state of 'flower of service' of different museums in Bangladesh.
- To identify the overall customer satisfaction about the services offered by the museums in Bangladesh.
- To analyze the customer satisfaction on different elements of flower of service model of museums in Bangladesh.

Based on the 4^{th} objective of the study, the following general null hypotheses were formulated:

H1: *Customers are either neutral or dissatisfied about the overall services of the museum.*

H2: *Customers of museums have an average opinion about the need of proper supplementary services to enhance the customer satisfaction of core services.*

H3: *Nosignificant relationship will be found between the customer satisfaction with museums and demographic variables (Gender, Age, and Occupation).*

1.3 Significance of the Study

The services offered by the museums are not always managed in an organized way. It is a general phenomenon in Bangladesh that the managers and the authority of the museums focus more on the core services rather than supplementary services or augmented services. But proper designing of supplementary services can create more customer satisfaction and positive experience. The outcome of this research will help the museum marketer to understand the need of designing supplementary services for gaining more competitive advantages and also give some idea about designing core and supplementary services with the help of flower of service model. This study will open the door of managing services in the museum in a new and improved way to increase the service satisfaction of the visitors and build a strong brand loyalty about the museum.

1.4 Scope of the Study

The study has focused on the visitors of different museums in Dhaka city. We have contacted with the visitors of five museums in Dhaka city for gathering data for this topic. The museums are Bangladesh National Museum, Ahsan Manzil Museum, Lalbagh Fort Museum, Liberation War Museum and National Museum of Science & Technology. It is already mentioned that no earlier research has yet been conducted on this area. From this study, we are trying to develop a common flower of service model for the supplementary services offered by museums in Bangladesh and also try to identify the present condition of services and analyze the level of customer satisfaction about the elements of flower of service. Moreover, this research is also helpful for anyone who will be interested to conduct further research in this arena.

2. Literature Review

Customer satisfaction with a product presumable leads to repeat purchases, acceptance of other products in the same product line, and favorable word-of-mouth publicity (Cardozo, 1965, pp. 244-249). Satisfaction is influenced by a consumer's assessment of the degree to which a product's performance is perceived to have met or exceeded his or her desires (desires congruency) and expectations (expectations congruency) (Sprend et al., 1996, pp. 60). Customer satisfaction / dissatisfaction (CS/D) is thought to be a relative judgment that takes into consideration both the qualities and the benefits obtained through a purchase as well as the costs and efforts borne by a customer to obtain that purchase (Ostrom & Dawn, 1996, pp. 59).

As recently stated by Sheng and Chen (2012, p. 53):

> In modern times, museums serve the functions of collection, research and exhibition, as well as education and recreation. They have gradually acquired visitor-based roles instead of museum based roles. Thus, the need for visitor studies has emerged.

Museums have several functions as custodians of heritage and culture, and disseminators of knowledge about heritage (Trinh & Ryan, 2013, pp. 239-263). They offer a diverse range of experiences to visitors (Rentschler, 2007, 345-365) which might be visual, sensory, esthetic, recreational, sociable, educational, celebrating and enchanting (Kotler & Kotler, 2000, pp. 271-287). In the past, public museums operated in the market with a supply orientation. In contrast, recently people have become more selective in the use of their leisure time. So museums are becoming increasingly market-oriented, paying greater attention to the wishes and needs of their visitors and the experience that they are in search of (Chiappa, 2014, pp. 420). Kotler (1998) describes the purpose of marketing in helping an organization contact and serves consumers; the purpose of marketing strategy in museums is establishing much audience and providing production and service (attracting and retaining visitors and providing continuous services), which is a unique museum's experience. Marketing brings the increase of audience, the increase of the profit and makes the audience feel it worthy. In the specific context of museums, Jeong and Lee (2006) showed that a consumer's emotional affect is influenced by the environmental attributes of the museum, which acts as a mediating variable shaping their satisfaction (Chiappa, 2014, pp. 423).The

added values of operating museum's marketing are not the final purposes of marketing. The marketing of museum makes the audience understand the purpose of museum and really makes them get the best visiting experience in the situation of museum in order to achieve education function. Many museums are organized around collections. They share the goals of acquiring and conserving their collections and interpreting and exhibiting this human and natural heritage to public audiences. They are expected to care for and preserve their collections as a public trust for future generations. Museums are places where visitors encounter authentic, aesthetic, inspirational, and learning experiences. They also function as interactive, recreational, and contemplative spaces. Museums are normally invested in missions that serve the public. They offer memorable experiences, ideas, and activities not found in other places (Kotler, 1998).

Figure-1: Degree of design and orchestration of museum experiences (Kotler, 1998)

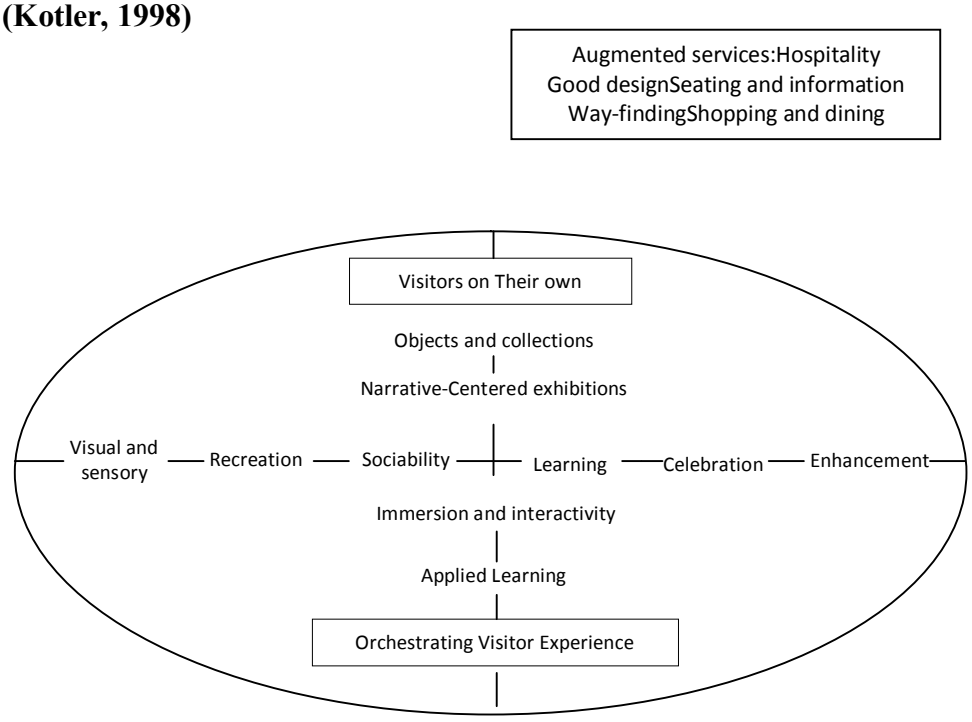
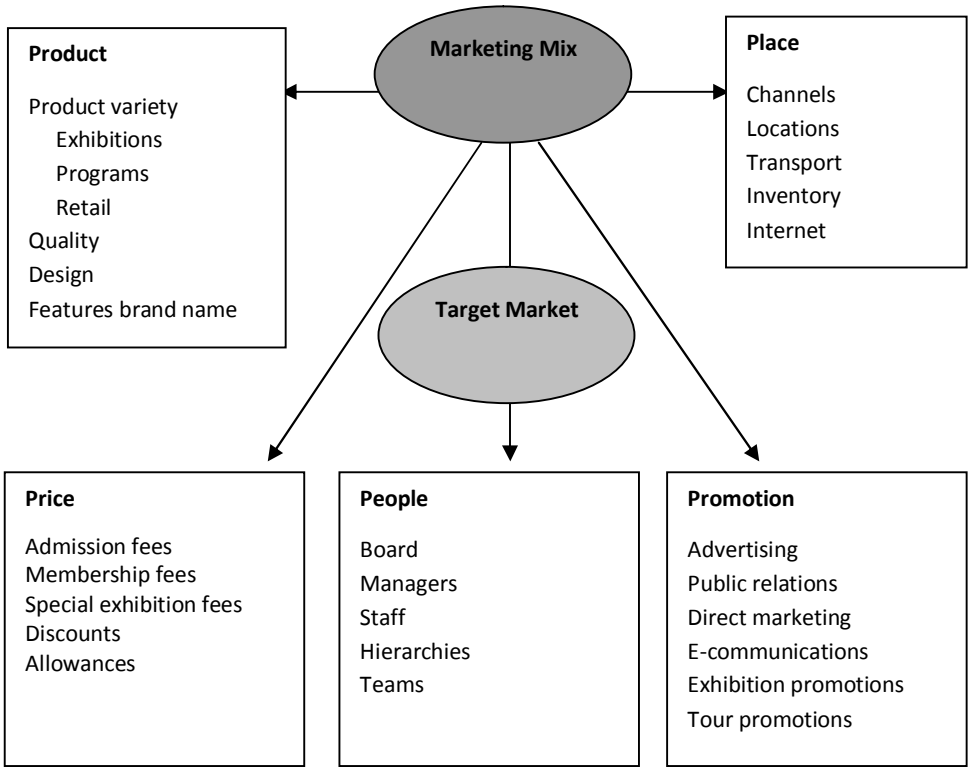


Figure-2: 5 P Elements of the museum marketing mix (Kotler, 1998)



Defining the Nature of the Service Offering

When designing a service to implement a particular service marketing concept, product planners need to take a holistic view of the entire performance they want customers to experience.

Core Product: The core product supplies the central problem-solving benefits that customer seek.

Supplementary Services: These elements augment the core product, both facilitating its use and enhancing its value and appeal. The extent and level of supplementary services often play a role in differentiating and positioning the core product.

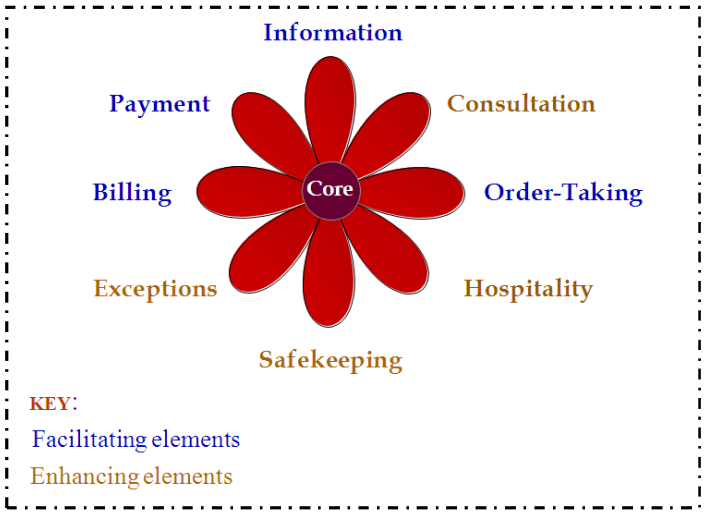
Flower of Service Model

Information: Customers often requireinformation about how to obtain and

use a product orservice. They may alsoneed reminders anddocumentation.

Order-Taking: Many goods and services must be ordered or reservedin advance. Customers need to know what is available andmay want to secure commitment to delivery

Figure-3: Flower of Service Model



(Source: Lovelock, Christopher. Et al. 2010)(Lovelock et al., 2011, pp. 81-92)

Billing: Customers deserve clear, accurate and intelligiblebills and statements.

Payment: Customers may pay faster and more cheerfully if youmake transactions simpleand convenient for them.

Consultation: Value can be added to goods and services byoffering advice andconsultation tailored toeach customer'sneeds and situation.

Hospitality: Customers who invest time and effort in visiting abusiness and using itsservices deserve to betreated as welcome guests.

Safekeeping: Customers prefer not toworry about looking afterthe personal possessions that they bring with themto a service site.They may also want deliveryand after-sales services forgoods that they purchase or rent.

Exceptions: Customers appreciate some flexibility in a businesswhen they make special requests. They expect itwhen everything does not goaccording to plan.

3. Methodology

This research is mainly descriptive in nature. Both primary and secondary sources of data have been used for this. For the study, primary data have been collected through questionnaire survey method. Both open and close ended questions were included in the questionnaire. Five point likert scale (Malhotra, 2011, pp. 268) has been used as a non-comparative scale to measure the satisfaction level. The researchers themselves were actively involved in data collection. Average questionnaire administering time was 20 minutes for each questionnaire. For secondary data different websites, prospectus, books and research reports were used.

Sample size and sample selection procedure

Target Population	Elements	Individual visitor of museum from Dhaka city.
	Sampling Unit	The visitors of five museums from Dhaka city.
	Extent	Fiver museums of Dhaka City.
	Time	March 2014 – October 2014
Sampling Frame	No well structured sample frame was found.	
Sampling Technique	Non Probability judgmental sampling procedure was used for selecting five museums and non probability convenience sampling procedure was used for selecting visitors.	
Scaling technique	5 point Likert Scale, which is a part of Non Comparative Scaling Technique	
Data Used	Primary and secondary	
Sample Size	150	

The sample size was 150 respondents from 5 different museums of three different types in Dhaka City. Non Probability judgmental sampling procedure was used for selecting 5 museums. One of the main reasons is

to get information from different types of museums. For selecting individual respondent non probability convenience sampling procedure was used.

The detail distributions of samples are given below:

No.	Name of the museum	Address	Type	Number of Respondents
1	Bangladesh National Museum	Shahbag, Dhaka 1000	General	30
2	Ahsan Manzil Museum	Ahsanullah Road, Dhaka 1100	Historical	30
3	Lalbagh Fort Museum	Lalbagh, Dhaka	Historical	30
4	Liberation War Museum	5 Segun Bagicha, Dhaka – 1000	Historical	30
5	National Museum of Science & Technology	Agargaon, Sher-E-Banglanagar, Dhaka-1207.	Science	30
			Total	**150**

Data Analysis and Reporting

Data have been analyzed through proper quantitative and qualitative techniques. We have used different types of statistical tools and computer software for analyzing and reporting, such as – SPSS v 23.0 and Microsoft Word. Simple statistical techniques like frequency distribution along with percentage and descriptive statistics like mean and standard deviations have been obtained. To determine whether a significant association exists between binomial variables (e.g. gender and customer satisfaction), cross tabulation analysis and chi-square test have been performed. One sample t-test was considered in testing hypothesis to analyze the level of customer satisfaction about overall services of the museum and their opinion about the need of proper supplementary services designing to enhance the customer satisfaction of core services.

4. Different Museums in Bangladesh

In this research we only consider five different museums and their services. This museums and the information about their services are given below:

4.1 Bangladesh National Museum

The present Bangladesh National Museum (1983) is the successor to the Dhaka Museum. Bangladesh National Museum is a four-storied building with a total exhibition area of more than 20,000 sqm. and 44 galleries. The Bangladesh National Museum has become one of the largest museums in South Asia. The Museum building comprises three auditoriums for holding seminars and cultural functions and a temporary exhibition hall for arranging special exhibitions. The Museum has a rich Library, an Audio-visual section, a Conservation Laboratory and a Photographic section. The Museum has two auditoriums - The Main Auditorium and Poet Sufia Kamal Auditorium and one hall room called Nalini Kanta Bhattsali Exhibition Hall and a modern and well-equipped conservation laboratory which provides necessary conservation and training facilities for other museums and laboratories of the country.

The museum has a public education department which arranges exhibitions, seminars, symposia and learned lectures, publishes catalogues, folders, and carries out research work on its collection. Education section deals with school programs, provides guide lecture service, mobile exhibition bus and holds art and hand writing competitions including various other competitions for children and arranges seminars, lectures and film shows. Other than this the foreign and native organizations and agencies can hold lectures, seminars, symposia, cultural functions and exhibitions at the Auditoriums and Exhibitions Halls on a rental basis. (Bangladesh national museum, 2013)

4.2 Ahsan Manzil Museum

Ahsan Manzil stands on the bank of the river Buriganga, at the southern part of Dhaka City. It was the palace of the Nawabs of Dhaka. In 1872 Nawab Abdul Ghani named it 'Ahsan Manzil' after the name of his son Khwaja Ahsanullah. The magnificent palace was renovated to a museum with 23 galleries and opened for visitors in 1992. Nearly 35,00 relics used by Nawabs have been kept at galleries of the museum. This museum is directly managed and controlled by the National Museum. Mainly national museum designs and provides services for this museum in accordance with their own service categories. (Bangladesh national museum, 2013)

4.3 Lalbagh Fort Museum

Lalbagh Fort (also known as "Fort Aurangabad") is an incomplete Mughal palace fortress beside the Buriganga River in the southwestern part of Dhaka, Bangladesh. The construction was started in 1678 by Prince Muhammad Azam. Lalbagh Fort is also the witness of the revolt of the native soldiers against the British during the Great Rebellion of 1857.

Lalbagh Fort Museum is situated inside the Lalbagh Fort. Shayesta Khan built this museum in the 17th Century. This Lalbagh Fort Museum is a two-storied building. A number of Mughal antiquities are on display here. The double-storeyed Diwan-i-Aam, attached with a single-storeyed Hammam on its west is an imposing building. The Hammam complex includes an open platform, a small kitchen, an oven, water storage area, a masonry brick bath-tub, a toilet, a dressing room and an extra room. A long partition wall runs north-south along the western facade of the Hammam, dividing the whole fort area into two divisions (Lalbagh Fort, 2013).

4.4 Liberation War Museum

The Liberation War Museum is located at the centre of Dhaka city and was inaugurated on March 22, 1996. It is registered as a Society with the Registrar of Joint Stock Companies and Firms, Bangladesh and also with the NGO Bureau of the Government of the People's Republic of Bangladesh. Over the last 13 years the museum has received 428, 629 visitors. There are 6 galleries which display the protracted struggle of the people of Bangladesh for establishing their identity as a nation under the British regime as well as their struggle against Pakistan for democracy, political and economic emancipation from 1947 and finally their armed struggle during the 9 month long War of Liberation in 1971.

Services Offered by the Museum

The primary focus of LWM is to educate new generation with history of independence so that they can feel proud of their motherland and get imbued with spirit of patriotism and liberal democratic ideas. This museum conducts outreach program where school students are brought to the museum in batches and visit the galleries. They also watch a video film on the Liberation War and the reasons behind the struggle and take part in a quiz program based on what they saw. The museum also organizes freedom festival regularly where outreach participants meet annually at a gala Freedom Festival addressed by government

functionaries, public leaders and cultural personalities. Other than this they also have a mobile museum where a big bus mounted with 360 photographs and objects acting as a mini-museum travels to the different parts of the country. The Museum holds regular special exhibitions on different aspects of the Liberation War. The museum runs a kiosk with souvenirs and books, which are on sale. It has a collection of books, published on the Liberation War. Liberation War Museum has a developed research centre where researchers can access documents, materials and books relating to Liberation War (Liberation War Museum, 2013).

4.5 National Museum of Science & Technology

National Museum of Science & Technology (NMST), is attached to the the Ministry of Science and Information & Communication, Government of the People's Republic of Bangladesh. It was formed under an executive order of the then Pakistan Government on April 26, 1965. This museum is functioning as a unitary body.

Services Offered by the Museum

a) Exhibitory Activities: The following galleries at present are functioning: Physical science gallery, Fun science gallery, Biological gallery, IT gallery and Technology gallery. Except these, some outdoor exhibits including Science park also exists. But students from schools/ colleges/universities can apply group wise for above exhibitions through their respective authority. They can also apply for free museum bus for their transport if the institution in Dhaka city. Sky observation through powerful telescope is organized on every Saturday and Sunday evening. The mini planetarium show is only held on every Saturday and Sunday normal exhibition time.

b) Educational Activities: it includes popular science lecture, scientific film show, Children science festival, Quiz contest, Seminar and Symposium, Library service, Internet browsing service, etc. Generally popular science lecture is held for a term of three-month duration on one lecture per week. The renowned scientists of the soil deliver science lectures. Subject matters may be Astronomical, Astrophysical, Cosmological, Medical, Biotechnological, Environmental or Contemporary scientific crisis.

c) Publications: 'Nabin Biggani' (Young Scientist) a quarterly science magazine, 'Udbhaban' (Innovation) a yearly report on young scientist,

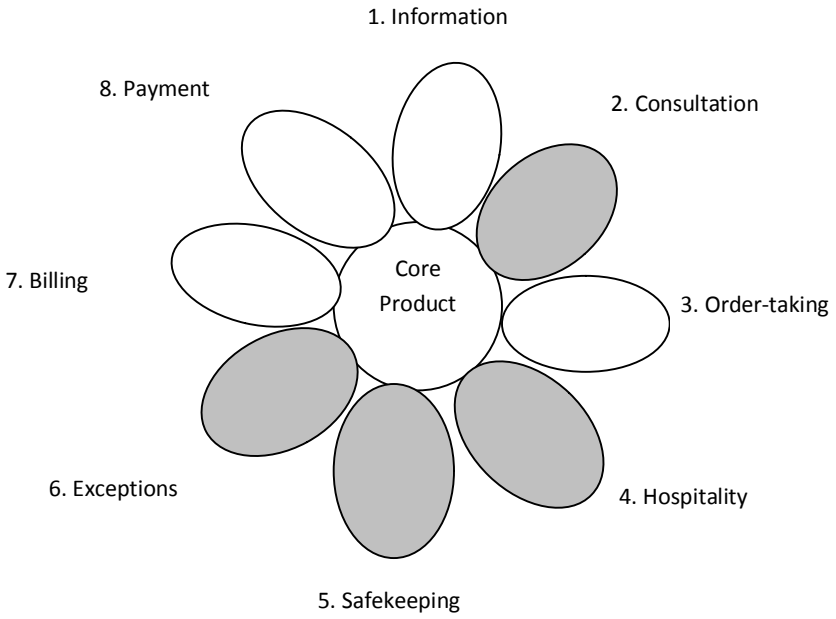
anyearly report on Science and Technology Week from national level are published.

d) Science Week &Activities: NMST arranges National Science & Technology Week every year in both district and national levels. The viable projects from the science weeks are encouraged to be developed further by Young scientist's activities.

e) Young Scientist Activities: NMST always encourages the young generation and helps them in the development of their potential projects. NMST helps them both financially and technologicallyNMST has an enriched workshop for their development of the Young Scientist's projects and museum exhibits. (National Museum of Science & Technology, 2013)

5. Flower of Service Model for Museums

Figur-4: Flower of Service for a museum



Core Product: Museum offers experience, ideas and satisfactions derived from authentic objects of nature, history, science and the arts that museum collect and display.			
Facilitating Services		**Enhancing Services**	
Information	• Direction to service site • Service hours • Prices • Warnings • Notifications of changes • Brochures • Websites: Videos, Internet	**Consultations**	• Customize advise • Training
Order-taking	Admission to restricted facilities: • Websites reservation • Membership	**Hospitality**	• Greetings and music • Toilets and washrooms • Waiting facilities • Transports • Dining facilities
Billing	Verbal statement of amount due Design of the ticket	**Safekeeping**	• Parking • Baggage handling • Security personnel
Payment	Hand to hand cash transferPrepaid tickets Insert card, token in machine	**Exceptions**	• Religious observations • Complaints and suggestions • Shopping facilities

6. Present State of Museums' Supplementary Services in Short

Supplementary services elements	**Bangladesh National Museum**	**Ahsan Manzil Museum**	**Lalbagh Fort Museum**	**Liberation War Museum**	**National Museum of Science & Technology**
Information	Moderately designed Information Services	No formal websites or information providing facilities	No formal websites or information providing facilities	Well structured websites and information providing facilities	Well structured websites and information providing facilities

Order-taking	No websites reservation or membership facilities.	No websites reservation or membership facilities.	No websites reservation or membership facilities.	Students' reservation facilities.	Students' reservation facilities.
Billing	Manual Ticket	Manual Ticket	Manual Ticket	Manual Ticket	Manual Ticket
Payment	No prepaid or digital cash transfer	No prepaid or digital cash transfer	No prepaid or digital cash transfer	No prepaid or digital cash transfer	No prepaid or digital cash transfer
Consultations	Provide training and laboratory facilities	No training facilities	No training facilities	Provide training and laboratory facilities	Training and project facilities
Hospitality	No transportation facilities	No dining and greeting facilities	No transport and dining facilities	Canteen facilities	Canteen facilities
Safekeeping	Problem with general parking facilities	Not parking and baggage handling facilities	Moderate security facilities	General parking facilities	General parking facilities
Exceptions	No shopping facilities other than academic	No shopping facilities	No shopping facilities	Book shopping facilities and freedom festivals	Arranging science and technology week, Free internet facilities

7. Findings and Discussion

7.1 Demographic Profile of the Respondents

Descriptive statistics on the sample in table 1 shows the profile of the respondents. From the research it is observed that out of 150 respondents 65.3% are male and 34.7% are female. Majority (54.7%) of the respondents (visitors) are young who fall into 24 years age group. Besides, it is clear from Table- 1 that majority of the respondents are students (52.0%).

So it can be concluded that majority of the respondents are young male age upto 24.

Table-1: Profile of the Respondents

Variables	Categories	Frequency	Percent
Gender	Male	98	65.3
	Female	52	34.7
Age	Up to 24	82	54.7
	25 - 34	55	36.7
	35 - 44	10	6.7
	45 - 54	3	2.0
Occupation	Service	35	23.3
	Business	16	10.7
	Housework	15	10.0
	Student	78	52.0
	others	6	4.0
Total (For each variable)		**150**	**100.0**

Reliability Test

The overall Cronbach's Alpha score for all 12 items to measure the level of customer satisfaction was 0.721. The reliability cannot be highly increased by deleting any items. Malhotra & Dash (2011) suggested that the minimum of 0.70 would be an acceptable level of reliability coefficient (pp. 279). Therefore, the data collected from the survey are reliable and obtained acceptable level of internal consistency.

Reason for Visiting Museum

The research shows that out of 150 respondents 10% visited the museum for learning, 55.3% for entertainment, 29.3% for refreshment, 2% for research and the rest 3.3% visited the museum for other purposes.

So it can be said that majority of the respondents came to the museum for getting entertainment by observing the collections of the museum on display.

7.2 Customer Satisfaction about Facilitating Service Elements

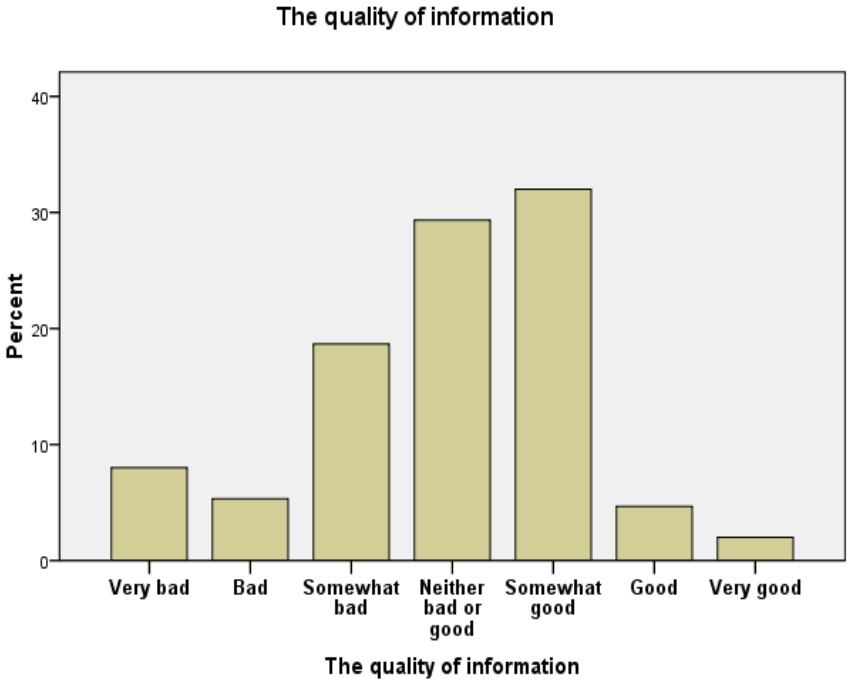
It was discussed in the literature review part that flower of service has eight components or petals. Out of these eight components, four can be grouped as facilitating service which is necessary to offer the core

services. Now the customer satisfaction about these components are described below

First it has tried to understand the effectiveness of information service of the museums by understanding the mental and physical hazard undertaken by the respondents to find out the location of the museums.

From the research it is found that out of 150 respondents 82.7% can easily find out the location of the museum but other 17.3% cannot do so. So it can be said that the museums disseminate enough information about their locations.

Quality of Information Provided by the Museum: The customer perceptions about quality of information provided by the museums are measured in 7 points scale. From the result it is found that total (32% + 4.7% +2%) = 38.7% respondents perceive that the quality of information provided by the museum is good. But (8% + 5.3% + 18.7%)= 32% perceive that the quality is bad and the rest 29.3% are in neutral position.



So it can be said that the only (38.7% - 32%) = 6.7% more respondents believe that quality of information is good rather than bad.

Table-2: Customer Satisfaction About Facilitating Service Elements

Facilitating Service Dimensions	Statements	Level of agreement (%)					Mean	Std. Deviation
		Strongly disagree	Disagree	Neutral	Agree	Strongly agree		
Information	I get all the information properly from the information desk or authority	18.0	18.0	26.0	36.0	2.0	2.86	1.15
Order Taking	The order taking service of the museum is fully satisfactory	2.0	14.0	49.3	30.7	4.0	3.21	0.81
Billing	The billing system of the museum is fully satisfactory	12.7	28.0	36.0	15.3	8.0	2.78	1.10
Payment	The payment system of the museum is fully satisfactory	3.3	12.0	28.0	36.0	20.7	3.59	1.05

From Table- 2, it is observed that out of 150 respondents, only (36% + 2% =38%) respondents have agreed with this statement that they get all the information services properly from the information desk or authority . But almost half of the respondent show neutral position about the satisfaction regarding order taking services. It is also found that majority (12.7% + 28% = 40.7%) of the respondents are not satisfied with the billing system of the museums. Besides this, majority (36% + 20.7% = 56.7%) of the respondents are satisfied with the existing payment system of the museums. The mean score of the information, order taking, billing and payment service dimensions are 2.86. 3.21, 2.78 and 3.59 consecutively in a five point scale ranging from Fully satisfied (Fully Agree = 5) to Fully dissatisfied ((Fully Disagree = 1). So, it can be said that museums have relatively more problem in information and billing services

7.3. Customer Satisfaction about Enhancing Service Elements

In the flower of service model, the rest four services are considered as the enhancing services which are not necessary for offering core service rather use for enhancing the brand image of the service.Now the customer satisfaction about these components are described below

Table-3: Customer Satisfaction about Enhancing Service Elements

Enhancing Service Dimensions	Statements	Level of agreement (%)					Mean	Std. Deviation
		Strongly disagree	Disagree	Neutral	Agree	Strongly agree		
Consultation	The consultation facilities of the museum are effective and satisfactory	0.0	22.7	44.7	30.7	2.0	3.1200	.77650
Consultation	The museum has qualified human resource for consultation service.	0.0	20.0	44.0	32.0	4.0	3.2000	.80268
Hospitality	The state of hospitality service of this museum is fully satisfactory	2.7	27.3	29.3	19.3	21.3	3.2933	1.16173
Safekeeping	The museum provides good safekeeping and security facilities.	14.7	16.0	38.7	17.3	13.3	2.9867	1.20951
Exceptions	The museum provides extra service facilities as per personal requirement	35.3	35.3	26.0	3.3	0.0	**1.9733**	.86658

From Table – 3, it is found that majority (44.7%) of the respondents are neutral about the satisfaction related to consultation facilities of the museum. They are also neutral (44%) about the qualification of the human resource of the museums for providing satisfactory consultation services to the customers. From the research, it is also found that majority (19.3% + 21.3%) = 40.6% of the respondents are satisfied about the hospitality services offered by the museum. But majority (38.7%) respondents are neutral about the level of satisfaction regarding safekeeping services offered by the museums. (35.3% + 35.3%) = 70.6% respondents showed disagreement on the statement which depicted that the museums provide extra or exceptional services. The mean score of the Consultation, Hospitality, Safekeeping and Exceptions service dimensions are consecutively 3.12. 3.2, 3.3 and 1.97 in a five point scale ranging from fully satisfied (Fully Agree = 5) to fully dissatisfied ((Fully Disagree = 1). So, it can be said that museums have serious problem in service exceptions.

7.4 CustomerSatisfaction on Overall Services Offered by the Museums

In this part to find out the customer satisfaction about overall services of the museums is attempted. The following is the general null hypothesis for this:

Null Hypothesis 1: *Customers are either neutral or dissatisfied about the overall services of the museum ($H_0 = 3$)*

To determine if the customer satisfaction level about the overall services of the museums is statistically significant, null hypothesis 1 has been tested using one sample t-statistics in 5% level of significance.

Table- 4: Test Result of General Null Hypothesis- 1

Statement	N	Mean	Std. Deviation	Std. Error Mean
The overall services of the museum fully satisfy my expectations.	150	3.5067	1.09144	.08912

Statement	**Test Value = 3**						
	t	**df**	**Sig.**	**Mean Difference**	**95% Confidence Interval of the Difference**		**Conclusion** (95% confidence level)
					Lower	**Upper**	
The overall services of the museum fully satisfy my expectations	5.686	149	.000	.50667	.3306	.6828	H_O is rejected;

From the test result, it is found that the customers of museums are satisfied about overall services of the museums. One of the reasons is that the young visitors are only aware of core services of the museums but they have little awareness about the supplementary services provided by the museums.

7.5 Role of Supplementary Services for Increasing the Satisfaction of Core Services of Museums:

In this an attempt is made to find out the customer opinion about role of supplementary services for increasing satisfaction about overall services of the museums.

Null Hypothesis 2: *Customers of museums have an average opinion about the need of proper supplementary services designing to enhance the customer satisfaction of core services.*

To determine whether designing of proper supplementary service can enhance customer satisfaction of core services, null hypothesis 2 has been tested using one sample t-statistics in 5% level of significance.

Table- 5: Test Result of General Null Hypothesis- 2

Statement	N	Mean	Std. Deviation	Std. Error Mean
Proper supplementary services designing can enhance the customer satisfaction of core services offered by the museum	150	3.4267	.71744	.05858

Statement	Test Value = 3						
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference		**Conclusion** (95% confidence level)
					Lower	Upper	
Proper supplementary services designing can enhance the customer satisfaction of core services offered by the museum	7.284	149	.000	.42667	.3109	.5424	H_O is rejected;

From the test result, it is found that the customers of the museums expect that proper supplementary service designing can enhance the customer satisfaction of core services offered by the museums.

7.6 Relationship Between Customer Satisfaction and the Demographic Variables of the Customer

To assess the association between customer satisfaction and different demographic variables like gender, age, and occupation, statistical analysis like cross-tabulations and chi-square tests were conducted. Moreover following general hypothesis were tested by chi-square, contingency coefficient and p- value. Following general hypothesis was checked with the statistical result:

Null Hypothesis 3: *No significant relationship will be found between customer satisfaction with museums and demographic variables (Gender, Age, and Occupation).*

Table- 6: Test Result of General Null Hypothesis- 3

Cross tabulation of Consumer awareness with following variables	Chi-square Value	Asymp. Sig. (2-sided) (p-value)	Contingency Coefficient	Conclusion (95% confidence level)
Gender	27.231	.000	.392	H_O is rejected; H_A is established
Age	11.01	.088	.261	H_O cannot be rejected
Occupation	28.274	.000	.398	H_O is rejected; H_A is established

From the above table, it is observed that for Gender and occupationp-value<0.05. But for Age p- value> 0.05. So, it can be said that Gender and Occupation are associated with consumer satisfaction with the museum. But there is no relationship between Age and satisfaction. But Rogers (1998) found that age had a small, positive relationship to customer satisfaction with museum (pp. 101)

Table- 7: Cross- Tabulation of Demographic Variables with Customer Satisfaction

Demographic variables		The overall services satisfaction			Total
		Dissatisfied	Neutral	Satisfied	
Gender of the respondents	Male	21.4%	46.9%	31.6%	100.0%
	Female	0.0%	26.9%	73.1%	100.0%
0ccupation of the respondents	service	20.0%	22.9%	57.1%	100.0%
	business	31.3%	56.3%	12.5%	100.0%
	housework	0.0%	26.7%	73.3%	100.0%
	student	11.5%	50.0%	38.5%	100.0%
	others	0.0%	0.0%	100.0%	100.0%
Total		14.0%	40.0%	46.0%	100.0%

From the above Table it is found that, female visitors are more satisfied with the museum than male visitors. Because women had a higher intention to return to museum than men (Harrison & Shaw, 2004, pp. 30). But some study shows that there is no relationship between customer satisfaction and gender of the respondents (Rogers, 1998, pp. 101). So further intensive research is needed for better understanding about the impact of demographic variables on customer satisfaction with museums.

8. Conclusion

Museum management is really a matter of meeting up the demands of the customers to satisfy them. Modern managers of the museums are trying to understand and embrace the need to attract visitors and other customers.

They are liable to play the key role in education, relaxation, community and cultural identity development, and attracting visitors. As the Flower of service model is one of the established measurements of services of any Service organizations, it was used to help the authority of the museums to better understand the services satisfaction of their museums. This study finds that the museums are providing the facilitating services which are moderate but are reluctant about the enhancement services, and that is why in most of the cases customers are either neutral or show the disagreement about the museum services. A moderate portion of the respondents agreed that they get the information properly but the quality of information is not satisfactory at all. They are not satisfied with the billing system but they are happy with the changes. Majority of the respondents feel neutral about the performance of human resources, and training and consultation services of the museums but they are satisfied with the hospitality services. So, it is recommended that museums should improve the facilitating services from moderate level to first-rate level and also bring the enhancement services at first-class level. The museums should also be equipped with skilled human resources, and the training and consultation services should be provided in such a way that will play a vital role in research and development activities as well as in the education of the students who are the most regular visitors of the museums.

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APPENDIX

(a) Questionnaire

Section 01(Personal Information)

1. Name of the Respondent: _____

2. Sex: 1. □ Male 2. □ Female

3. Age:

4. Occupation: a) Service b) Business c) Housewife d) Student, f) Others

Section 02 (General Information)

5. Why have you visited a museum?

a) Learnig, b) Entertainment, c) Refreshment,

d) Research, e) Others…..

6.Do you face any hazardto find the location of this museum?

a) Yes, b) No

Section- 3 (Facilitating Element)

7. "I get all the information properly from the information desk or authority"

a) Strongly Agree, b) Agree, c) Neutral

d) Disagree, e) Strongly Disagree

8. The quality of information is _____

Very good	7	6	5	4	3	2	1	Very bad

9. "The order taking service is fully satisfactory."

a) Strongly Agree, b) Agree, c) Neutral

d) Disagree, e) Strongly Disagree

10. "The billing system (ticket collecting process) is fully satisfactory"

a) Strongly Agree, b) Agree, c) Neutral

d) Disagree, e) Strongly Disagree

11. "The payment system is satisfactory."

a) Strongly Agree, b) Agree, c) Neutral

d) Disagree, e) Strongly Disagree

Section- 4 (Enhancing Elements)

12. "The consultation facility of the museum is effective and satisfactory."

a) Strongly Agree, b) Agree, c) Neutral

d) Disagree, e) Strongly Disagree

13. "They museum has qualified human resource for consultation."

a) Strongly Agree, b) Agree, c) Neutral

d) Disagree, e) Strongly Disagree

14. "The state of hospitality service of this museum is fully satisfactory"

a) Strongly Agree, b) Agree, c) Neutral

d) Disagree, e) Strongly Disagree

15. "The museum provides good safekeeping and security facilities"

a) Strongly Agree, b) Agree, c) Neutral

d) Disagree, e) Strongly Disagree

16. The museum provides extra service facilities as per personal requirement-

a) Strongly Agree, b) Agree, c) Neutral

d) Disagree, e) Strongly Disagree

17. Proper supplementary services designing can enhance the customer satisfaction of core services offered by the museum -

a) Strongly Agree, b) Agree, c) Neutral

d) Disagree, e) Strongly Disagree

18. The overall services of the museum fully satisfy my expectations-

a) Strongly Agree, b) Agree, c) Neutral

d) Disagree, e) Strongly Disagree

(b) Tables

	Cronbach's Alpha if Item Deleted
I get all the information properly from the information desk or authority	.664
The quality of information is	.718
The order taking service of the museum is fully satisfactory	.746
The billing system of the museum is fully satisfactory	.734
The payment system of the museum is fully satisfactory	.730
The consultation facilities of the museum are effective and satisfactory	.684
The museum has qualified human resource for consultation service.	.697
The state of hospitality service of this museum is	.661
The museum provides good safekeeping and security facilities.	.662
The museum provides extra service facilities as per personal requirement	.744
Proper supplementary services designing can enhance the customer satisfaction of core services offered by the museum	.687
The overall services of the museum fully satisfy my expectations.	.679

Reliability Statistics

Cronbach's Alpha	N of Items
.721	12

Dynamics of Firm Size and Performance Relationship: Evidence from the Banking Sector of Bangladesh

Md. Kaysher Hamid

Abstract

This study investigates the firm size and performance relationship in the context of banking sector of Bangladesh. 23 commercial banks listed with Dhaka Stock Exchange (DSE) for 2004-15 have been selected. Return on Assets (ROA) is used as the performance indicator and the natural log of total assets and the natural log of market capitalization have been considered as size indicators while leverage ratio serves as the control variable. Correlation analysis has found a positive association of ROA with the natural log of market capitalization and the negative association with the natural log of total assets and leverage ratio. Panel data regression has concluded a significant relationship between the firm performance and the size expressed by natural log of total assets and the insignificant relationship between firm performance and the size expressed by natural log of market capitalization. Control variable i.e. leverage ratio has shown a negative and significant relationship with ROA.

Keywords: Size, Performance, Profitability, Bank, Bangladesh

1. Introduction

Firm size is deemed to be an important factor in determining a firm's profitability (Kumar and Kaur 69-78; Lee 189-203). First logical explanation of this statement is based upon the concept of economies of scale as the big firms due to their large production units can enjoy decreasing marginal cost and they can also be benefitted from economies of scope by sharing or merging different front and back office facilities. Risk level calculated for a firm when making the funding decision by an outside investor also favors the large firms. Small firms negatively affected due to the overstatement of risk by the capital market, therefore, are charged higher interest rates (Amato and Burson 67-81). High financing cost inflates the cost structure of small firms and squeezes the margin. In a competitive market, large market share captured by the big firms also keeps little room for the growth of the smaller ones and an aggressive marketing campaign by a big one may wipe out a small firm

from the market or force to merger with or be acquired by others for survival. Big firms can also allocate more funds for their research and development (R&D) and come up with innovative products now and then. But there are also counter arguments.

Big firms are not believed to be as flexible as the small. A small firm may take the advantage of popped up market opportunity readily where in a big firm, the accord of different management positions may require considerable time. Small firms can also efficiently serve a market niche with their limited production capacity which a large firm may find inefficient. A big firm serves a large market, therefore, focuses on the standardization of products where small firms because of their little market share can focus on providing unique and customized experience to the customers. Because of this, they may charge a premium price too.

So, there can be seen the contrasts of arguments regarding the effect of the firm size on performance. Previous researches also show a disagreement among the findings. John and Adebayo (1171-1175), Babalola (90-94), Serrasqueiro and Nunes (195-217), Vijayakumar and Tamizhselvan (44-53) and Hall and Weiss (319-331) in their studies have found a positive size-performance relationship where Becker-Blease et al. (7-23) and Jónsson (43-55) have found a negative relationship. Conversely, Niresh and Velnampy (57-64) andWhittington (335-352) have found no significant relationship between the firm size and the performance.

2. Banking Sector of Bangladesh: An Overview

Banking sector plays a pivotal role in accelerating the development of a country by ensuring efficient allocation of resources among different economic entities (Ahmed 44). Bangladesh is not an exception. The emergence of the banking sector in Bangladesh can be traced from 1971 when after independence the government of Bangladesh nationalized the existing banks mostly owned by West Pakistanis (Islam et al. 70-107) and renamed and reorganized those. There were six nationalized commercialized banks, two state-owned specialized banks and three foreign banks at the beginning. Before 1980's the banking sector was mostly owned and controlled by the government which resulted in weak asset quality, insufficient provisioning maintenance, low profitability of this sector, and negative capitalization of several state banks (Jahan and Muhiuddin 13-22). In the earliest part of 1980, the financial reform

program led by the IMF and the World Bank brought liberalization and privatization in this sector which created the growth opportunities for private entities (Ahamed 1-18).

At present, 57 scheduled banks and 6 non-scheduled banks are operating in Bangladesh. The major distinction between these are scheduled banks run under Bank Company Act, 1991 (Amended upto 2013) whereas non-scheduled banks function according to respective acts enacted for serving special purposes (Islam and Hamid 25-42). Scheduled banks can further be classified as state-owned commercial banks (6), specialized banks (2), foreign commercial banks (9), and private commercial banks (40); those are divided into conventional banks (32) and IslamiShariah based banks (8). The banks can also be classified based on their year of incorporation i.e. first generation banks (before 1991), second generation banks (1992-98), third generation banks (1999-2010), and fourth generation banks (2011-present).

Table 1: Income, Expenditure, and Profitability of Scheduled Banks of Bangladesh

Particulars		2011	2012	2013	2014	2015
						(Taka in Crore)
Total Income	SOBs	13,224.12	15,725.25	16,728.02	18,486.49	20,782.27
	FOBs	4,378.41	5,603.35	5,985.94	5,906.70	5,407.47
	PCBs	41,050.18	52,221.36	57,658.75	61,356.65	64,033.43
	SPBs	1,818.91	1,592.26	1,794.89	2,163.79	2,035.30
	Total	60,471.62	75,142.22	82,167.60	87,913.63	92,258.47
Total Expenditure	SOBs	8,569.50	11,794.04	13,949.00	15,256.82	17,852.88
	FOBs	1,925.60	2,796.43	3,007.39	2,721.73	2,514.02
	PCBs	29,079.70	38,973.79	44,904.27	46,637.05	48,463.98
	SPBs	1,996.95	1,228.45	2,210.87	1,791.26	2,539.12
	Total	41,571.75	54,792.71	64,071.53	66,406.86	71,370.00
Net Profit After Tax	SOBs	1,799.33	(6,522.88)	2,258.44	1,227.44	365.93
	FOBs	781.04	1,465.12	1,464.63	1,706.03	1,695.81
	PCBs	6,999.28	3,962.68	4,644.27	5,511.02	6,145.79
	SPBs	(208.04)	86.49	(448.50)	48.86	(3,504.21)
	Total	9,371.61	(1,008.59)	7,918.84	8,493.35	4,703.32

Notes: SOBs= state-owned commercial banks, FOBs = foreign commercial banks, PCBs =private commercial banks, SPBs = specialized banks
Source: Monthly Economic Trends, July 2017, Bangladesh Bank

Table 1 shows the performance of scheduled banks of Bangladesh in terms of income, expenditures, and net profit after tax for 2011-15. It can be observed that total income, expenditures, and profit of the scheduled banks are increasing over the years except the profit in 2012. In this year, there was a loss of Tk. 1008.59 crore which was mainly driven by a net loss after tax of Tk. 6522.88 crore of the SOBs. Individually, PCBs are generating the highest income over the years followed by SOBs, FOBs, and SPBs. Except some years, the same general trend can be identified for expenditures and net profit after tax. Compared to 2011, in terms of growth, total income of SOBs in 2015 has increased by 57.15% where it was 55.99% for PCBs, 23.50% for FOBs, and 11.90% for SPBs. SOBs also showed the highest growth of 108.33% in expenditures for 2015 followed by 66.66% of PCBs. But, SOBs had the negative growth of 79.66% in a net profit after tax whereas only FOBs showed positive growth of 117.12%.

3. Literature Review

Size-performance relationship hasbeen widely studied by the academicians in the context of different sectors, countries, time frames, and conceptual frameworks. Different size and performance indicators have been used in those studies. Doğan explored this relationship for 200 companies of Istanbul Stock Exchange (ISE) for 2008-11 and incorporated return on assets (ROA) as an indicator of profitability and total assets, total sales, and number of employees as size indicators (53-59). By controlling for firm age, leverage and liquidity, his study concluded a positive relationship between size and profitability.

John and Adebayo also found a positive size-performance relationship for manufacturing sector of Nigeria (1171-1175). They investigated 5 beverages manufacturing firms for 2005-12 and used ROA as a representative of profitability and log of total assets and log of turnover for size. Besides, they also controlled the relationship for liquidity, leverage and inventory management ratio. Positive relationship is also observed by Babalola for Nigerian manufacturing sector (90-94). He studied 80 non-financial listed firms for 2000-09 and found that total assets and sales have positive relationship with ROA.

For small and medium sized companies of Portugal, Serrasqueiro and Nunes have identified a positive significant relationship between company size and performance (195-217). Positive relationship has also

been concluded by Papadogonas for the manufacturing companies of Greece (14-20), Vijayakumar and Tamizhselvan for companies in South India (44-53) and Hall and Weiss for Fortune 500 companies of the United States (319-331).

On the other hand, by studying the USA manufacturing companies for 1987-2002, Becker-Blease et al. identified a significant negative relationship between firm size (total assets, total sales and number of employees of the firms) and profitability (7-23) while Jónsson found a negative but insignificant size-performance relationship by examining 250 Icelandic firms (43-55). Negative relationship was also identified Kouser et al. by studying 70 non-financial companies of Pakistan for 10 years (405-419).

However, Niresh and Velnampy explored this relationship for Sri Lanka by incorporating 15 companies of Colombo Stock Exchange (CSE) for 2008-12 and considered ROA and net profit as profitability indicators and total assets and total sales as size indicators (57-64). They found no significant relationship between the size and profitability variables. Whittington also failed to identify any size-performance relationship for UK firms (335-352).

In the perspective of Bangladesh, no comprehensive study on firm size-performance relationship has been found. Some authors have addressed this relationship partly in their studies. Hasan et al. analyzed 36 firms listed with Dhaka Stock Exchange (DSE) for the period of 2007-12 and concluded a negative insignificant relationship between the firm size expressed by logarithm of total assets and the return on assets (ROA) (184-194). But, Rouf considered the financial data of 106 manufacturing companies listed with DSE for 2008-11 and identified that the total asset has a positive significant relationship with ROA (25-32). On the hand, Haque and Faruque estudied 14 pharmaceutical companies for 2005 to 2011 and found no significant relationship between the share price and the ROA (34-41) which can further be interpreted as the non-existence of relationship between the market capitalization and the ROA.

Based on the above literatures, it can be understood that no conclusive decision can be given regarding the size-performance relationship. It varies based on the scopes of the studies. It can also be observed that most of the studies are conducted by incorporating manufacturing companies. Banking and non-banking financial institutions

have received little attention in earlier works. Moreover, until now, based on the author's exploration, no full-fledged study on this topic has been found in the context of Bangladesh. Therefore, this research work tries to provide some insights regarding the firm size and performance relationship in Bangladesh perspective.

4. Research Objective and Questions

The objective of this research is:

- To identify the relationship between the firm size and the firm performance in the banking sector of Bangladesh

And, the following questions are answered to fulfill the research objective

- What is the relationship between profitability and total assets in the banking sector?
- What is the relationship between profitability and market capitalization in the banking sector?

5. Research Methodology

5.1 Sample

As of December 31, 2015, 30 banks were listed with Dhaka Stock Exchange (DSE). Among them, the banks listed for more than 10 years are initially selected for this study and 24 banks fall in that category. As ICB Islamic Bank Limited is a problematic bank, this bank is excluded from the initial sample. So, final sample of this study includes 23 banks for the period of 2004 to 2015. Annual reports of these banks have been collected from their respective websites and DSE library. Data stated in the audited financial statements have been used.

5.2 Model and Variables

To study the size-performance relationship the following model is used:

$$\mathbf{Y_{it} = \alpha_0 + \beta_1 X_{1it} + \beta_2 X_{2it} + \beta_3 X_{3it} + \ldots\ldots\ldots + \beta_n X_{nit} + e_{it}}$$

Where,

- Y represents the dependent variable;
- $\alpha_0$is the intercept;
- $\beta_1, \beta_2, \beta_3 \ldots\ldots\ldots\ldots \beta_n$ are regression coefficients;
- $X_{1it}, X_{2it}, X_{3it}\ldots\ldots\ldots\ldots X_{nit}$ are independent variables;
- e_{it} is the estimation error.

Here, return on assets (ROA) representing firm performance is used as the dependent variable. Natural log of total assets (LNTAS) and natural log of market capitalization (LNMKTCAP) are considered as the representatives of firm size and incorporated as the independent variables. Leverage ratio (LEV) acts as the control variable.

$$\text{Model I: } ROA_{it} = \alpha_0 + \beta_1 LNTAS_{it} + \beta_2 LEV_{it} + e_{it}$$
$$\text{Model II: } ROA_{it} = \alpha_0 + \beta_1 LNMKTCAP_{it} + \beta_2 LEV_{it} + e_{it}$$

Table 2: Variables of this Study

Dependent Variables	
• ROA	= Profit after Interest and Taxes / Total Assets * 100
Independent Variables	
• LNTAS	= Natural Logarithm of Total Assets
• LNMKTCAP	= Natural Logarithm of Market Capitalization
Control Variables	
• LEV	= Total Liability/Total Assets

5.3 Hypothesis

With the above models, the following hypothesis would be tested:

H_{01}: There is no significant relationship between ROA and LNTAS in the Banking Sector of Bangladesh

H_{A1}: There is a significant relationship between ROA and LNTAS in the Banking Sector of Bangladesh

H_{02}: There is no significant relationship between ROA and LNMKTCAP in the Banking Sector of Bangladesh

H_{A2}: There is a significant relationship between ROA and LNMKTCAP in the Banking Sector of Bangladesh

5.4 Data Analysis

Data are analyzed with widely accepted statistical tools i.e. descriptive statistics, correlation analysis and regression analysis. Microsoft Excel (version 2013) and Stata (version 13) are used to run these statistical tools. Descriptive statistics and correlation analysis are conducted with Microsoft Excel (version 2013) and panel data regression is done by Stata (version 13).

6. Analysis and Discussions

6.1 Descriptive Statistics

Table-3 shows the descriptive statistics of the variables. It can be observed that mean ROA is 1.274% and leverage ratio (LEV) is 92.3%. Average natural log of total assets (LNTAS) and natural log of market capitalization (LNMKTCAP) is 25.147 and 23.150 respectively. Minimum standard deviation and range is observed for LEV. Negative skewness of ROA, LNTAS, and LNMKTCAP is indicating extension of tails to left and negative kurtosis of LNTAS and LNMKTCAP is indicating relatively flat distribution of these variables.

Table 3: Descriptive Statistics of the variable

	ROA	LNTAS	LNMKTCAP	LEV
Mean	1.274	25.147	23.150	0.923
Standard Error	0.067	0.049	0.050	0.002
Standard Deviation	1.107	0.816	0.835	0.030
Kurtosis	116.471	(0.582)	(0.266)	13.523
Skewness	(8.444)	(0.139)	(0.226)	2.196
Range	18.616	4.183	4.396	0.288
Minimum	(13.516)	23.128	20.765	0.846
Maximum	5.100	27.310	25.160	1.134
Count	276	276	276	276

6.2 Correlation Analysis

The result of correlation analysis is presented in Table 4. It shows that LNMKTCAP has a positive correlation with ROA but LNTAS and LEV have negative correlations. Lower correlation coefficient values of LEV with LNMKTCAP and LNTAS are indicating weak association between the independent and control variables. So, the chance of multico linearity in significantly affecting the result can be rejected.

Table 4: Correlation Matrix

	ROA	LNMKTCAP	LNTAS	LEV
ROA	1.00			
LNMKTCAP	0.14	1.00		
LNTAS	(0.07)	0.72	1.00	
LEV	(0.56)	(0.34)	(0.28)	1.00

6.3 Firm Size and Performance Relationship

To explore the size-performance relationship, panel data regression i.e. fixed effect and random effect is conducted. For identifying whether fixed or random effect model is the best fit for explaining this relationship Hausman test is done.

6.3.1 Regression of ROA and Total Assets

Table 5 shows the fixed effect regression result between ROA and LNTAS. It can be observed that 37.43% of the variance of dependent variable i.e. ROA can be explained by independent variable (LNTAS) and control variable (LEV). The model has Significance F value lower than 0.05 which indicates the validity of this model. LNTAS and LEV have negative coefficients with ROA and p values are lower than 0.05, therefore, indicating significant relationship between ROA and total assets.

Table 05: Fixed Effect Regression of ROA and LNTAS

Fixed-effects (within) regression				Number of obs		=	276
Group variable: b				Number of groups		=	23
R-sq:	within	=	0.3127	Obs per group:	min	=	12
	between	=	0.7167		avg	=	12.0
	overall	=	0.3743		max	=	12
				F (2, 251)		=	57.09
corr (u_i, Xb)		=	-0.4236	Prob> F		=	0.0000

roa	Coef.	Std. Err	t	P>|t|	[95% Conf.	Interval]
lntas	-.4836013	.0841759	-5.75	0.000	-.6493824	-.3178201
lev	-27.37967	2.565353	-10.67	0.000	-32.43204	-22.32731
_cons	38.7029	3.880508	9.97	0.000	31.06039	46.3454
sigma_u	.31878843					
sigma_e	.86707667					
rho	.11907704	(fraction of variance due to u_i)				
F test that all u_i = 0			F(22, 251) = 1.28		Prob> F = 0.1843	

Random effect model in Table 6 does not show a much better result than the fixed effect model. Here, this model captures 37.68% of the variation of dependent variable which was 37.43% for fixed effect model. This model is also statistically significant. Coefficients of the predictors are negative and p values are also lower than 5%. Therefore, the model is suggesting the rejection of null hypothesis.

Table 6: Random Effect Regression of ROA and LNTAS

Random-effects GLS regression				Number of obs		=	276
Group variable: b				Number of groups		=	23
R-sq:	within	=	0.3094	Obs per group:	min	=	12
	between	=	0.7302		avg	=	12.0
	overall	=	0.3768		max	=	12
				Wald chi 2 (2)		=	163.94
corr (u_i, X)		=	0 (assumed)	Prob> chi 2		=	0.0000

roa	Coef.	Std. Err	z	P>|z|	[95% Conf. Interval]	
lntas	-.3443179	.067767	-5.08	0.000	-.4771388	-.211497
lev	-23.33	1.834949	-12.71	0.000	-26.92643	-19.73357
_cons	31.46298	2.724587	11.55	0.000	26.12289	36.80307
sigma_u	.04105813					
sigma_e	.86707667					
rho	.00223723	(fraction of variance due to u_i)				

Hausman test is run to identify the appropriate model among fixed and random. The hypothesis of the test is:

Null Hypothesis : Random effect model is appropriate
Alternative Hypothesis : Fixed effect model is appropriate

From Table 7, it can be observed that probability (0.0204) is lower than 0.05. So, the null hypothesis can be rejected and it can be concluded that fixed effect model is appropriate here.

Table 7: Result of Hausman Test for ROA and LNTAS

	Coefficients		(b-B) Difference	sqrt (diag (V_b-V_B)) S.E.
	(b) fe	(B) re		
lntas	-.4836013	-.3443179	-.1392834	.0499322
lev	-27.37967	-23.33	-4.049674	1.792763
b = consistent under Ho and Ha; obtained from xtreg B = inconsistent under Ha, efficient under Ho; obtained from xtreg				
Test: Ho: difference in coefficients not systematic chai2(2) = (b-B) ‘ [(V_b-V_B) ^ (-1)] (b-B) = 7.78Prob> chi2 = 0.0204				

6.3.2 Regression of ROA and Market Capitalization

Fixed effect regression of ROA and LNMKTCAP (table 08) is illustrating that 32.11% of the variance of dependent variable (ROA) is explained by the independent variable (LNMKTCAP) and control variable (LEV). This model is statistically significant as Significance F value is lower than 0.05. But, p value of LNMKTCAP is higher than 5% which indicates an insignificant relationship between ROA and LNMKTCAP. However, LNMKTCAP and LEV have negative coefficients with ROA.

Table 8: Fixed Effect Regression of ROA and LNMKTCAP

Fixed-effects (within) regression				Number of obs	=	276
Group variable: b				Number of groups	=	23
R-sq:	within	=	0.2255	Obs per group: min	=	12
	between	=	0.7430	avg	=	12.0
	overall	=	0.3211	max	=	12
				F (2, 251)	=	36.54
corr (u_i, Xb)		=	-0.0050	Prob> F	=	0.0000

roa	Coef.	Std. Err	t	P>|t|	[95% Conf.	Interval]
lnmktcap	-.0914297	.0896361	-1.02	0.309	-.2679645	.0851052
lev	-21.54808	2.772574	-7.77	0.000	-27.00856	-16.08761
_cons	23.27649	4.049617	5.75	0.000	15.30093	31.25204
sigma_u	.24614894					
sigma_e	.92042099					
rho	.06674565	(fraction of variance due to u_i)				
F test that all u_i = 0			F(22, 251) = 0.86		Prob> F = 0.6525	

Random effect model is not showing an improved result than the fixed effect one in Table 9. Against 32.11% of R square value in fixed effect, here, it is 32.12%. Though the F test is indicating that coefficients in the model are different than zero, the independent variable has p value higher than 5%, therefore, there is no significant relation between ROA and market capitalization.

Table 9: Random Effect Regression of ROA and LNMKTCAP

Random-effects GLS regression					Number of obs		=	276
Group variable: b					Number of groups		=	23
R-sq:	within	=	0.2254		Obs per group:	min	=	12
	between	=	0.7438			avg	=	12.0
	overall	=	0.3212			max	=	12
					Wald chi 2 (2)		=	129.18
Corr (u_i, X)		=	0 (assumed)		Prob> chi 2		=	0.0000

roa	Coef.	Std. Err	z	P>|z|	[95% Conf. Interval]	
lnmktcap	-.0776934	.0704179	-1.10	0.270	-.21571	.0603232
lev	-21.41748	1.947294	-11.00	0.000	-25.23411	-17.60085
_cons	22.83796	2.812641	8.12	0.000	17.32529	28.35064
sigma_u	0					
sigma_e	.92042099					
rho	0	(fraction of variance due to u_i)				

The result of Hausman test for this relationship is shown in table 10. As we've seen in earlier test, this model assumes that random effect is appropriate as null hypothesis and fixed effect as alternative. Here, p value (0.9537) is higher than 5%, therefore, by accepting the null hypothesis, it can be concluded that random effect model is appropriate for studying this relationship.

Table 10: Result of Hausman Test for ROA and LNMKTCAP

	Coefficients		(b-B) Difference	sqrt (diag (V_b-V_B)) S.E.
	(b) fe	(B) re		
lnmktcap	-.0914297	-.0776934	-.0137362	.0554613
lev	-21.54808	-21.41748	-.1306051	1.973629

b = consistent under Ho and Ha; obtained from xtreg
B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic
chai2(2) = (b-B) ' [(V_b-V_B) ^ (-1)] (b-B)
= 0.09
Prob>chi2 = 0.9537

7. Hypothesis Testing

Based on the above analysis, by considering the findings of fixed effect model for ROA and LNTAS regression and random effect model for ROA and LNMKTCAP regression, it can be said that there is a significant relationship between firm performance and firm size as expressed by total assets which indicates the rejection of hypothesis H_{01} and simultaneous acceptance of hypothesis H_{A1}. On the other hand, no significant relationship is identified between firm performance and firm size as expressed by market capitalization which suggests the acceptance of hypothesis H_{02}.

Table 11: Result of Hypothesis Testing

Hypothesis		Basis	Result
H_{01}:	There is no significant relationship between ROA and LNTAS in the Banking Sector of Bangladesh	Fixed Effect Model	Rejected
H_{A1}:	There is significant relationship between ROA and LNTAS in the Banking Sector of Bangladesh		Accepted
H_{02}:	There is no significant relationship between ROA and LNMKTCAP in the Banking Sector of Bangladesh	Random Effect Model	Accepted
H_{A2}:	There is significant relationship between ROA and LNMKTCAP in the Banking Sector of Bangladesh		Rejected

8. Conclusion

Financial sector of Bangladesh is largely dominated by banks. In an economy of Tk. 17,295.7 billion (The World Bank 53) 63 banks are running their businesses simultaneously. From 1980's, different financial reform programs have shaped the banking sector by regulating different aspects of banking practice like standardizing accounting system, capital adequacy maintenance, provisioning for non-performing loans, and increased disclosure requirements (Khatun 14) but there still remain some weaknesses. Banking sector has shown mismanagement in adequate capital and non-performing loan maintenance which ismostly observed for state-owned commercial banks. Moreover, lacks of profitable lending opportunities have burdened the banks with excess liquidity which is affecting their bottom lines. In addition, financial irregularities as

manifested by embezzlement of money from Sonali Bank and BASIC Bank and heist of reserve from Bangladesh Bank are also threatening for this sector. These highlight the needs of good governance and policy reforms in this sector. Academicians and researchers can play active roles in this case by addressing different facets of the banking sector and sharing their findings with the concerned authorities for making this sector more capable in meeting the challenges of the future world. This research also tried to contribute to this arena by studying the firm size and performance relationship.

By studying 23 banks for 12 years, it is found that in the banking sector of Bangladesh, total assets has a significant negative impact on banks performance as expressed by return on assets. It means that if the total asset of bank increases, other things remaining constant, profitability of the bank would decrease in Bangladesh. This finding is contrary to the general assumption that a firm with high assets would generate a higher profit. It also contradicts with the findings of Doğan (53-59), John and Adebayo (1171-1175), Babalola (90-94), Serrasqueiro and Nunes (195-217), Vijayakumar and Tamizhselvan (44-53) and Hall and Weiss (319-331).But, this result is in support of the findings of Becker-Blease et al.(7-23), Jónsson (43-55), and Kouser et al.(405-419).It can also be explained by our previous discussions on profitability of the banking sector. In 2011, total net profit after tax of the banking sector was Tk. 9,371.61 crore but in 2015 this amount stood at Tk. 4,703.32 crore whereas in these years the number of banks and the assets of this sector have increased. So, it is apparent that the banks could not keep harmony between the size and the performance and this negative relationship is justifiable.

On the other hand, market capitalization has a negative but insignificant impact on the performance of a bank. Therefore, a bank with high market capitalization or stock price doesn't necessarily mean the superior profitability of the firm. This result is in line with the findings of Naveedand Ramzan(41-57),Shamsudin et al. (409-413) and Haqueand Faruquee (34-41) but contradicts with the conclusions of Kabajeh et al. (115-120), Dadrasmoghadam and Akbari (586-591), and Arkan (13-26). Finally, this research has considered only 23 banks, a further study on this subject by incorporating all banks of Bangladesh is suggested. In addition, this conceptual framework can also be applied to explore the size-performance relationship in other sectors of Bangladesh.

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Impact of the Foreign Exchange Reserve on the Stock Market Development: Evidence from the Dhaka Stock Exchange

Md. Methun-Al-Mamun

Abstract

This paper investigates the causal linkage between the foreign exchange reserve and the stock market development in Bangladesh for a data period of 1995 to 2014. This study follows a simple linear regression model, the unit root test using ADF test, Johansen co integration test, granger causality test to measure the relationship between foreign exchange reserves of Bangladesh and stock market capitalization. This study also employs the multivariate framework incorporating inflation and interest rate variables. The results show there exists a unidirectional causal relationship between the market capitalization and foreign exchange reserve, the inflation and market capitalization but no causal relationship between the interest rate and the market capitalization. It can be concluded that stock market growth will be enhanced by increasing the nation's foreign exchange reserves.

Key words: Foreign exchange reserve, market capitalization, Co integration test, unit root.

JEL classification: C01, F31, E31, E22

1. Introduction

It has always been a debate whether there exists any association between the foreign exchange reserve and the stock market capitalization, whether stock market growth is increased by foreign exchange reserves or foreign exchange reserves are increased by stock market growth or whether a two-way relationship exists. Foreign exchange reserves are foreign currency assets held by the central banks of the countries. These assets include foreign marketable securities, monetary gold, special drawing rights (SDRs) and the reserve position in the IMF. The main purpose of holding foreign exchange reserves is to make international payments and hedge against exchange rate risks.

On the other hand, Market capitalization is the aggregate valuation of the company based on its current share price and the total number of outstanding share of stock. It is calculated by multiplying the current market price of the company's share with the total outstanding shares of that company. Dhaka Stock Exchange (DSE) is the major and earliest stock exchange of Bangladesh, which is situated at the main area of Dhaka city. On 28th April 1954, DSE was formed as a public limited company which was established and registered under Company Act 1994, and supervised by the Security and Exchange Commission Act 1993, the the Security and Exchange Commission Regulation 1994, the Security Exchange (Inside Trading) Regulation 1994. Presently, DSE has 564 listed security members. On August 10, 1998 DSE introduced the screen-based state-of –the-art automated online real- time trading through local area network (LAN) & wide area network (WAN). On January 24, 2004 Central Depository System (CDS) for electronic settlement of share trading made debut in the DSE. The Dhaka Stock Exchange has become a full Depository Participant (DP) of CDBL to facilitate the non-DP members. It has 536 listed securities with Tk. 1, 032.1 billion issued capital and Tk. 2, 943.2 billion market capital till the fiscal year 2014.

Historically, the Bangladesh Stock Market (DSE General) reached an all-time high of 8918.51 in December of 2010 and a record low of 282.43 in October of 1991.

Figure 1 shows that both the stock market capitalization and the foreign exchange reserve have a significant growth over the years in Bangladesh. In the year 1994-95 the market CAP was Tk. 3,496.51crore and in 2013-14 Tk. 23, 8626.301crore. Here total market CAP is increased by Tk. 23, 5130 crore within these 20 years. It has a through increase from 2005-06 with Tk. 20350.2 crore to 2013-14 in Tk. 2, 38, 626.301 crore except the year 2011-2012 and 2012-13. And in 2010 the second stock market crash was the because of this decreasing Market CAP.

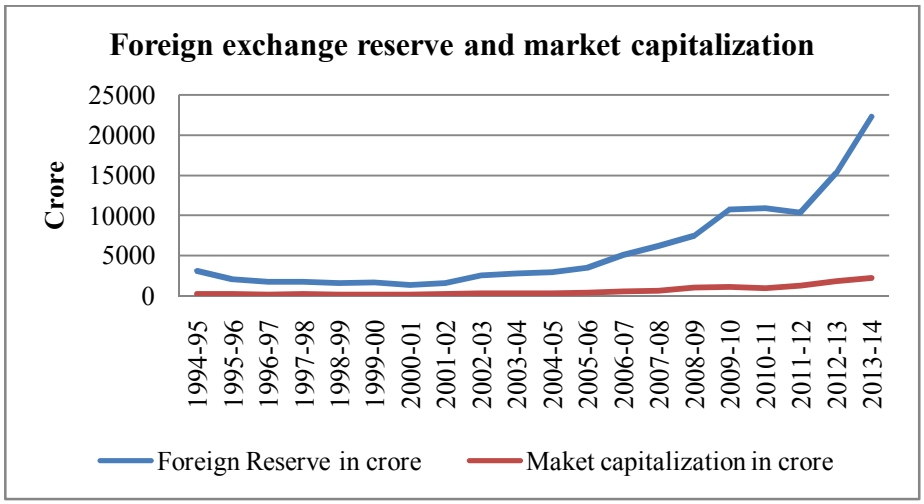

Figure 1: Foreign exchange reserve and market capitalization

Source: Bangladesh Bank Database

At the same time there was a significant growth of foreign exchange reserves over the years. Though there was a decreasing amount of Tk. 3,069.6 crore in 1994-95 to Tk. 1,306.7 crore in 2000-01, from 2001 it again came to the increasing trend. It was increased from Tk. 1,582.9 crore in 2001-02 to Tk. 22,309.8 crore in 2013-14. During the last two years there was a vast increase i.e. Tk. 10,364.4 crore in 2011-12 to Tk. 22,309.8 crore in 2013-14.

Increasing remittances from expatriates abroad and rising export incomes have boosted these reserves over the years. Dropping costs of imports, especially food and fuel have also helped restrict forex outgo and boosted reserves.

2. Literature Review

A significant number of empirical researches have been conducted to examine the causal relation between the macroeconomic variables and the stock market growth. But research on the causal relation specifically between the foreign reserve and the stock market growth is not mentionable in Bangladesh though it is available in other countries like India, Pakistan, Nigeria, Iran etc. At the very beginning, without incorporating the foreign exchange reserve, Nishat and Shaheen (2004) examined the impact of five macroeconomic variables- industrial product index, consumer price index and money supply on the Karachi Stock

Market by using Johansen's (1991 and 1995) vector error-correction model (VECM) with a data set of Quarterly period of 1973:1 to 2002:4 . They found that those five variables were cointegrated and industrial production was the greatest positive determinant of Pakistani stock prices, while the largest negative determinant was inflation. By applying multivariate model with a data set from 1990 to 2004 of the United States and the United Kingdom, Dimitrova (2005) developed a relationship between the foreign exchange rate and stock price. He analyzed it with a hypothesis that there is a link between the foreign exchange rate and the stock markets development. He asserted a positive relation between them when stock prices are the lead variable and negative relation when exchange rates are considered as lead variable.

An empirical result of the short-run relationship and the long-run equilibrium relationship among selected macroeconomic variables, trading volume, stock returns on the Athens stock exchange for the period 1990 to 1999 came from Patra and Poshakwale (2006); Short run and long run equilibrium relationship exists between inflation, money supply and trading volume and the stock prices in the Athens stock exchange. No short run or long run equilibrium relationship was found between the exchange rates and the stock prices. Interest rate has a great impact on the stock exchange to provide important implication for monitory policy, risk management practices, financial securities valuation and government policy towards financial markets Alam & Uddin (2009). Using ordinary least-square (OLS) regression method Ologunde et al (2006) investigated the relationships between the interest rate and the stock market capitalization rate in Nigeria. They found that stock market capitalization rate was positively influenced by the prevailing interest rate and negative influenced by government development stock rate. Also, they found that prevailing interest rate exerts negative influence on the government development stock rate.

Andreas & Macmillan (2007) applied the co integration analysis with data set from the period of January 1965 until June 2005 in the US and Japan; they analyze the relationship between the stock prices and key macroeconomic factors. Using those data they found that there is a single co integrating vector existing in the US and two co integrating vectors existing in Japan. In US, stock prices were influenced positively by industrial production and negatively by inflation and the long interest rate. However, they found the money supply had an insignificant influence over the stock price. In Japan, one vector normalized on the stock price

provided evidence that stock prices are positively related to industrial production but negatively related to the money supply. And in second vector, normalized on industrial production, that industrial production was negatively related to the interest rate and the rate of inflation. Ahmed & Imam (2007) investigated the relationship among different macroeconomic variables and the stock market growth. By the analysis from different tests like co integration, unit roots and vector error correction models and using monthly data from July 1997 to June 2005 they found that there is no long run relationship among macroeconomic variables i.e. money supply, Treasury bill rate, interest rate, GDP, industrial production index. But the market return is someway influenced by interest rate change or T-bill growth rate.

Besides the interest rate, inflation is significantly impacted by the foreign reserve. Chaudhry, I. S. et al (2011) conclude the negative and significant relationship between the foreign exchange reserves and the inflation rate in Pakistan. Liu & Shrestha (2008) examined an empirical relationship between the Chinese stock market with industrial production, exchange rate, inflation, money supply and interest rate. They collected the secondary data of those variables from January 1992 to December 2001 and applied the heteroskedastic cointegration test for getting the result. They found a positive relationship between the industrial production and the money supply on the Chinese stock indices where inflation, interest rate and exchange rate have a negative effect on share prices. Alagidede, P. et al (2010) examined the causality between the exchange rates and the stock prices in Australia, Canada, Japan, Switzerland, and the UK with the data from January 1992 to December 2005 using the Granger causality test in linear and nonlinear framework. They found the causal linkage between the exchange rate and the stock prices. By using unit root test, co integration and error correction mechanism on quarterly data from January 1995 to December 2008, Pal & Mittal (2011) evaluated the relationship between two Indian capital markets with interest rates, inflation, exchange rate and gross domestic savings. They showed that the interest rate and the foreign exchange rate have an effect on one capital market but both the capital markets are influenced by the inflation rate with no significant effects of gross domestic saving in either of these markets.

Though most of the researchers talk on the impact of the different macroeconomic variables on the stock market growth, but specifically very few of them mention only the causal relation between the foreign

exchange reserve and the stock market growth in certain areas. By using simple linear regression model, unit root test, granger causality test with the data set from the year 1990-91 to 2010-11, Ray (2013) found that the foreign exchange reserves of India has a positive impact on the Bombey Stock market capitalization. Moreover, the results showed that there was unidirectional causality from the foreign exchange reserves to the stock market capitalization. Akinlo (2015) investigated a relationship between the foreign exchange reserves and the stock market development in Nigeria over the period 1981-2011. The results showed that foreign exchange reserves have a positive effect on the stock market growth. Abakah & Abakah (2016) showed a reasonable impact of foreign exchange reserve on stock market growth by employing monthly data for the period from December 2001 to December, 2015 in Ghana. They found a unidirectional relationship between the foreign exchange reserve and the stock market capitalization. A few studies of Akinlo (2015), Abakah & Abakah (2016), Ray (2013), actually focus on the relationship between the foreign exchange reserve and the share market capitalization, but in our country no one has done any work on this specific topic yet. As we should know about the relationship between them, this study deals with that particular arena focusing on the causality relation between the foreign exchange reserve and the stock market development.

3. Data Analysis and Research Methodology

3.1 Research Design

With a view to pinpointing the link between the foreign exchange reserves and the stock market development a function has been developed in which the stock market development depends on the foreign reserves. The stated equation for the analysis is

$$SMD = f(FER) \qquad E\ (1)$$

However, it is relevant to consider other variables which are supposed to have influential effects of the stock market development of a particular country. The exclusion of these variables could bias the direction of causality between the foreign exchange and the stock market development. Consequently, to conduct this study two supporting macroeconomic variables inflation and interest rate have been considered. Therefore the equation becomes like

$$SMD = f(FER, INF, INT) \qquad E\ (2)$$

Taking the log results in

$$ln\,SMD = \alpha + \beta_1\,ln\,FER + \beta_2\,ln\,INT + \beta_3\,ln\,INF + \varepsilon \qquad E(3)$$

Where *SMD* stands for the stock market development measured by the stock market capitalizationi.e.calculated by multiplying the current **market** price of the company's share with the total outstanding shares of the company.*FER* is foreign exchange reserves, *INT* is the interest rate, and INF is the inflation rate.

To conduct the study both the descriptive and the econometric analyses have been used. For the purpose of descriptive statistics mean and standard deviations have been calculated of the countries concerned to pinpoint the central distribution and graphical analyses have been used to figure out the trend of the selected variables during the study period 1995-2014. Therefore, first part of this study describes the following analyses to identify the relationship and the trend of the variables used in the study:

- Descriptive Statistics[1]
- Graphical Analysis
- Stationarity Test (Phillips-Perron's Unit Root[2] Test and ADF test)
- Co integration Test along with Granger Causality test of the variables has been executed using STATA v. 9.0 and Microsoft EXCEL.

3.2 Model Specification

3.2.1 Unit Root Test

For the purpose of the study macroeconomic variables have been chosen. Macroeconomic variables are supposed to be non-stationary (Nelson and Plosser, 1982) and unless they are co integrated are conducive to spurious regression. So, stationarity of the series has to be examined. For this reason, an Augmented Dickey- Fuller (ADF) test has been conducted.

[1] Mean and standard deviation of Money Supply, Inflation, and Deficit of the selected countries

[2] pperron uses Newey–West (1987) standard errors to account for serial correlation, whereas the augmented Dickey–Fuller test implemented in dfuller uses additional lags of the first differenced variable.

3.2.2 Co Integration Test

With a view to conducting this study Johansen (1998) and Johansen and Juselius (1990) maximum likelihood co integration technique is used, which tests both the existence and the number of co integrating vectors. When non stationary time series become stationary after differencing then it can be said that the series is co integrated.

3.2.3 Model on Granger Causality

To examine the causal relationship among the selected variables a trivarate Granger Causality Model is utilized. The suitable design of the model depends on the status of the unit roots of the variables of interest and on the existence of co-integration between the variables. If variables are co-integrated, then there exists causal relationship between variables (either unidirectional or bidirectional).

4. Analytical Findings

4.1 Summary Statistics

Data analyzed of this study have been collected covering the period of 1995-2014. Table 1 demonstrates the summary statistics of the study. Data are collected from the central bank of Bangladesh. All variables are in logarithm.

Table 1:Summary Statistics

	FER	MCAP	INF	INT
Mean	5725.86	71230.27	6.24	8.61
Standard Error	1257.41	20346.39	0.62	0.3
Median	2999.8	17267.65	6.92	8.46
Standard Deviation	5623.29	90991.84	2.79	1.34
Sample Variance	31621490.15	8.28E+09	7.82	1.81
Kurtosis	2.83	-0.66	-0.12	0.81
Skewness	1.71	1.06	-0.63	0.58
Range	21003.1	235129.8	10.64	5.65
Minimum	1306.7	3496.51	-0.02	6.04
Maximum	22309.8	238626.3	10.62	11.69
Sum	114517.2	1424605	124.89	172.11
Count	20	20	20	20

Note: FER and MCAP are expressed in crore and INF and INT are expressed in %

The summary statistics disclose that all the series exhibit a high level of reliability as their mean and median are within the maximum and minimum values of the series. Also, the standard deviations showing the deviations of the actual data from their mean values are relatively low except for market capitalization

4.2 Stationarity Test

For the stationarity test of the variables Augmented Dickey Fuller (ADF) Unit Root Tests have been conducted. The null hypothesis is that the variable is non stationary and the alternative hypothesis is that there exists stationarity. A stationary time series data is one whose statistical properties such as mean, variance, autocorrelation, etc. are all constant over time. Most statistical analyses are based on the assumption that the time series can be rendered approximately stationary.

Table 2: Augmented Dickey Fuller (ADF) Unit Root Tests

Variables	Test statistic		Critical values at 5% level	Stationarity status	
	Level	1st difference		Level	1st difference
MCAP	-0.320	-3.536	-3.000	Non stationary	Stationary
FER	1.426	-3.193	-3.000	Non stationary	Stationary
INF	2.982	-7.028	-3.000	Non stationary	Stationary
IR	-2.918	-3.132	-3.000	Non stationary	Stationary

From the Table 2 it is evident that all the variables are non stationary at level as their test statistics are less than the critical values. Hence the null hypothesis of non stationarity is not rejected in that case. It is also apparent that the variables are stationary after taking the 1st difference even though they are non stationary at levels.

4.3 Cointegration Test

The presence and the number of co-integrating relationships among the underlying variables are tested through a vector error correction model applying the Johansen procedure. To test for co integration it should be specified how many lags to be included. If there exists a stationary linear combination of non stationary random variables, the variables combined are said to be co integrated. Since it is unknown that the appropriate lag

structure to be used therefore, lag length selection test[3] have been carried out.

Table 3: Cointegration Test

Lag	LL	LR	Df	P	AIC	HQIC	SBIC
0	37.6627				-3.7403	-3.71302	-3.54244
1	83.8805	92.436	16	0.000	-7.09783	-6.96142	-6.10853*
2	106.762	45.764*	16	0.000	-7.86249*	-7.61695*	-6.08174

From Table 3 it is perceived that Hannan–Quinn information criterion (HQIC) method selects two lags, Schwarz Bayesian information criterion (SBIC) method selects one lag, sequential likelihood-ratio (LR) selects two lags as indicated by the "*" in the output. Since the variables are stationary at 1st difference Johansen tests of cointegration has been applied as shown in Table 4.

Table 4: Johansen Tests for Cointegration

Maximum Rank	LL	Eigen value	Trace Statistics	5% critical value
0	74.183171		65.1584	47.21
1	90.855013	0.84314	31.8148	29.68
2	101.88776	0.70649	9.7493*	15.41
3	106.7622	0.41819	0.0004	3.76
4	106.76239	0.00002		

To tests co integration Johansen's method has been used. Test statistics are based on a model with two lags and a constant trend. Table 4 presents test statistics and their critical values of the null hypotheses of no co integration and one or fewer co integrating equations. The eigenvalue shown on the last line is used to compute the trace statistic in the line above it. Johansen's testing procedure starts with the test for zero co integrating equations (a maximum rank of zero) and then accepts the first null hypothesis that is not rejected. Johansen's testing procedure starts with the test for zero co integrating equations and then accepts the first null hypothesis that is accepted. In the output above, the null hypothesis of no co integration has been rejected and the null hypothesis of at most two co integrating equations is not rejected.

[3] In the process of determining lag length fixed maximum lag length of two has been selected sample size is too small.

Thus, the null hypothesis that there are maximum two co integrating equations in the model is accepted. Hence the variables are nonintegrated meaning that they have association in the long run.

Table 5: VECM model

	Ln MCAP	Ln FER	Ln INF	Ln IR
Constant	.0608128 (.184)	.0409069 (0.164)	-.0028395 (0.948)	.0025009 (0.881)
L1	-.1500633 (.462)	-.0584253 (0.656)	-.7327823 (0.000)	-.7508265 (0.010)

From Table 5 it is apparent that there is no long run causality running from market capitalization to foreign exchange reserve, inflation, and interest rate.

To test for serial correlation in the residuals Lagrange-multiplier test for residual autocorrelation has been conducted. From Table 6it is apparent that there is no residual autocorrelations up to two lag lengths at 5% level of significance.

Table 6: Lagrange-multiplier Test for Residual Aautocorrelation

Lag	$\chi 2$	df	Prob>$\chi 2$
1	12.2321	16	0.72785
2	24.7495	16	0.07436

To check whether the residuals are normally distributed Jarque-Bera test has been conducted and here the null hypothesis is that the residuals or variances are normally distributed. It is apparent from Table 7 that for the first model of interest rate the null hypothesis is not rejected at 5% level of significance. This is true for rest of the models of inflation, market capitalization, and foreign exchange reserve.

Table 7: Jarque-Bera Test

Equation	$\chi 2$	df	Prob> chi2
Ln IR	1.333	2	0.51343
Ln INF	0.850	2	0.65388
Ln MCR	0.260	2	0.87817
Ln FER	0.112	2	0.94552
ALL	2.555	8	0.95912

4.4 Granger Causality Model

After fitting the coinegration test, it should be verified whether one variable "Granger-causes" another (Granger 1969). Following table shows the variables under consideration along with their respective Prob>χ2.

Table 8: Granger Causality Wald Tests

Equation	Excluded	χ2	df	Prob> χ2
Market capitalization	Foreign exchange reserve	8.4105	2	0.015
Market capitalization	Inflation	6.3649	2	0.041
Market capitalization	Interest rate		2	
Market capitalization	All	.21062	6	0.900
		28.7		0.000
Foreign exchange reserve	Market capitalization	.69678	2	0.706
Foreign exchange reserve	Inflation	.70588	2	0.703
Foreign exchange reserve	Interest rate		2	
Foreign exchange reserve	All	4.2302	6	0.121
		8.349		0.214
Inflation	Market capitalization	1.9201	2	0.383
Inflation	Foreign exchange reserve	7.9843	2	0.018
Inflation	Interest rate		2	
Inflation	All	10.096	6	0.006
		50.086		0.000
Interest rate	Market capitalization	2.5013	2	0.286
Interest rate	Foreign exchange reserve	1.4476	2	0.485
Interest rate	Inflation		2	
Interest rate	All	1.6275	6	0.443
		13.363		0.038

In the test the null hypothesis is the foreign exchange reserve which does not granger cause the market capitalization. By considering the result in that case the null hypothesis is rejected (Prob>chi2=.015<.05) that means the foreign exchange reserve has a causal linkage with the market capitalization for Bangladesh. The same conclusion can be made in case of inflation and market capitalization. The last test is with respect to the null hypothesis of all variables. In that case the null hypothesis is rejected. The bottom line for that equation of the market capitalization is that all the variables jointly granger causes the market capitalization for Bangladesh. Following the same process for the second equation the null hypothesis of no causal relationship between the market capitalization and the foreign exchange reserve is not rejected which means the market capitalization did

not granger cause the foreign exchange reserve. Same conclusion can be drawn for both inflation and interest. In case of the equation of inflation the null hypothesis that market capitalization does not have any causal relationship with inflation is not rejected. Which means market capitalization does not cause inflation. But for foreign exchange reserve and interest rate the null hypotheses are rejected which means both of these macroeconomic variables have causal relationship with inflation. However, all of the variables jointly cause inflation. From the last equation of interest rate it is apparent that null hypothesis of no causal relationship is not rejected. But all of the variables (market capitalization, inflation, foreign exchange reserve) jointly cause interest rate.

5. Conclusion

This study analyzes the relationship between the foreign exchange reserve and the stock market development taking interest rate and inflation as supporting variables. To figure out the relationship a series of econometric models have been applied. This study employs Augmented Dickey-Fuller (ADF) unit root test to pinpoint the stationarity of the data set and johansen juselius cointegration test. The study shows that foreign exchange reserve and interest rate positively and significantly affect the stock market development. The results demonstrate a unidirectional causal relationship between the market capitalization and the foreign exchange reserve, between inflation and the market capitalization but no causal relationship between interest rate and market capitalization. From the above analysis it is highlighted that there is a need of well managed macroeconomic policies in order to obtain the benefits from the capital market. In order to take the full advantage of the stock market and carry on with the international markets well managed macroeconomic policies are necessary in which interest rates and inflation rate are thoroughly monitored and controlled as much as possible. It will increase the confidence to the investors as well as the industries.

The possibility for future research is to further evaluate what are the other determinants that affect the stock market capitalization and where fluctuations in that case are coming from. Even though this study reveals the interconnection between some selected macroeconomic variables and the stock market development, other variables may affect the stock market development. However the present study is limited to only three selected macroeconomic variables. Inclusion of more variables with a longer time period may contribute to better findings.

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Occupation Selection Opportunities for Rural Women in Bangladesh: Challenges and Possibilities

Safina-E-Ferdous

Abstract

Women are contributing to many changes in rural areas of Bangladesh. In many sectors, they are making new grounds. Most women are working for salary – especially underprivileged women. Their work is poorly salaried, uncertain, and often periodic. They frequently do the work that men do not want to do, and every time occupation that can better-off women decline. Undertaking these 'bad occupations' may need breaking social rules, making tough selections about childcare or compromising their health. Examples of these occupations include post-harvest work, road construction, and domestic service. The article reveals that despite the various difficulties of the type and nature of work available to poor women in low skill and poor returns, the chance for women to accept a more waged work is a positive one. This article also focuses that in the case of the selection of occupation women are now breaking social norms and desperately they are trying to ensure their better future.

Keywords: Occupation, rays of hope, social norms, livelihood, women

1. Introduction

Men and women experience changes differently. There will be substantial differences in access to new opportunities and services. And a changing context – evolving institutions, improvements in physical infrastructure and so on – will have different implications for men and women. In the village, people are getting better arrangement and fast transportation support. As a result, the Women of most remote areas are benefitted from these developments. The progress of education, health and economic condition affects countryside women's social and cultural life immensely. Women are noticeably working in the outdoors, walking in groups to school, using public transport and even vending in the bazaar (N Kabeer and S Mahmud, 2003). As the girls' presence at school has increased rapidly, and expectations that 'a girl can do many things have changed

parents' early marriage thinking. The growing incidence of violence against women – particularly young girls, restricts their livelihoods choices. Besides this, there are many other reasons that control the livelihood choices of rural women in Bangladesh. Very small range of occupation selection options leads them at health risk and security problem (Behrman and Anil, 1990). Especially sexual violence affects the occupation selection a lot. In spite of all of these barriers, rural women and girls are contributing enormously to change their lives, future, and the social norms of the country.

1.1 Objective

During 2015-2016, the writer carried out an assessment of rural livelihoods in Bangladesh. This evaluation was conducted in a spirit of open inquiry with questions such as:

- What are lives and livelihoods like today for men and women in rural Bangladesh?
- How is life changing?
- What expectations do women have for their children?

This article provides preliminary answers to the question: what are lives and occupations like at present for females and teenagers in rural Bangladesh?' The above queries discovered the variations females and teenagers saw happening in their lives, the differences they estimated and what they perceived as the occupation effects of those changes. Rather than constructing a complete picture of employment through a designed assessment, the study focuses on trends, broad directions of change and new opportunities and threats that were emerging as a result of the changing rural context. This article priorities the voices and views of women and girls themselves.

2. Methodology

This study conducted by using the qualitative method, is based on rural perspective because the majority of poor people in Bangladesh reside in the countryside. The materials have been collected carefully and precisely of this work. In two weeks of field work, the writer visited 11 villages in rural North-West and South-East of Bangladesh, one Dhaka slum, and one peri-urban site 45 miles outside Dhaka and also convened a session with six female and four male urban garment workers. The field discussions were with relatively large groups of people, first with a combined group of

men and women, and then with sex-segregated groups. All efforts were made to ensure that the groups included a range of women and girls from a variety of social and economic positions. The discussions included very old women, abandoned women, better off women, teens (in school and out of school), garment workers, landless agricultural labourers, and women who did not undertake any paid work at all.

3. Rural Bangladesh is Changing Fast

Substantial changes are taking place in the rural life of Bangladesh. Like the growth in the status of nonfarm work and the growing urbanisation of rural life. However, the distinction between what is rural and what is urban in Bangladesh is diminishing quickly, and villagers are now closer than ever to urban areas through migration, improved communication and transport links, and the increasing penetration of 'urban' phenomenon such as consumerism and entertainment.

Women spoke of decreased maternal death and a rise in the reception and accessibility of skillful presence at birth. Women and teens rapidly take up new conveyance opportunities. A great revolution for the young and teens has been the introduction of money for education and stipend packages in the school sector. There is an extensive appreciation of the importance of girls' presence at the school. It is currently considered usual, even important that girls attend secondary schools. These girls, endowed by more education than their mothers or grandmothers dreamed of, denote a potent 'ray of hope' for Bangladesh. But still fewer can complete Secondary School Certificate (SSC) as well as Higher Secondary Certificate (HSC) levels, and it is a cause of anxiety. The development of physical structure is motivating the changes in rural Bangladesh – specifically roads and bridges, electrification and the expansion of marketing outlets. These services are creating rural scenery progressively 'urban' in character and completely changed the life of the rural people.

3.1 The Livelihoods of Rural People are in a State of Constant Change

New livelihood opportunities are emerging, frequently in the non-farm section. The number of shops, dressmaking, and other expertise enterprises, rickshaw pullers, small traders in villages and local market centers are developed significantly. Remittances now form a significant part of the rural economy. Nevertheless, change is quicker in some areas than in others and for some individuals more than the others. There is a

continuum rather than a division – from areas where traditional views and images of rural life still hold true, to areas where a more 'modern' way of life is taking hold (Ellis, 2000).

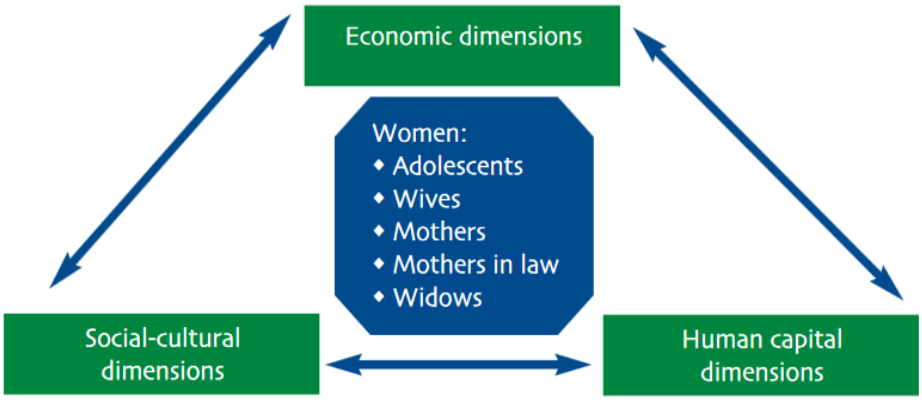
3.2 People Experience Change Differently

These changes affect people differently. Some people have been able to embrace the change; those with some access to capital, labour and markets have been able to take up the new opportunities. Others have fared less well; for many of the poor, their primary asset remains their labour; a strong pair of hands is dangerous to their occupations. However, whether they are involved in agricultural labouring or the non-farm sector, they continue to be marginalised from the development process(Gill and Ganesh, 2007).

3.3 But What AboutWomen and Girls?How Have they Fared?

The framework will help understand the impact of change on women and girls as emerged from the fieldwork (Figure 1).

Figure 1 A framework for understanding change



At the centre of the framework are women and girls themselves – it is their opinion and observation that lie at the heart of this study. The central box reminds that women and girls do not share a single identity. Their ability to take the advantage of new opportunities and the impact of change on them is strongly influenced by factors such as the stage they are at in their life cycle and their social position. This is a critical determinant of their authority and autonomy, their preferences, their household status and the livelihood options open to them. A determining moment comes with

marriage, motherhood and the quality of the relationships with husbands and in-laws. Female-headed households, whether de jure (widowed, divorced or abandoned) or de facto (where the man is absent from the home for a long period of time), often struggle to achieve authority and status and access opportunities.

The changes that women and girls spoke about fall broadly into the three categories highlighted in Figure 1:

- The change in the economic front (mainly in the form of new income earning and livelihood options)
- The change in the social-cultural front
- The change in human capital

These three categories are by no means inclusive of all the changes that are important to women and girls in Bangladesh, but they are vocal of their most prominent interests and concerns. The change in one dimension obviously has an impact on and implications for other elements of women's and girls' livelihoods. These relationships (sometimes positive and sometimes not) are represented by the arrows in the framework. An example of this dynamic is the emergence of the garment and other factory work for women and girls; it is, at first look, an economic phenomenon relating to wages and spending power. However, a second look shows that the ascendancy of garment work also has profound social effects (more women in public places, women exerting more influence in the household) and human capital effects (some increased health risks, possible implications for quality of children's care (Halder and Mosley, 2004).

3.4 Economic Dimensions of Change for Women

Frankly speaking, women have always worked hard in Bangladesh, as in every other country. What is relatively new is the growing number of rural and urban women who are undertaking paid work, mainly paid work outside home. Perhaps the most prominent change that women and girls spoke about was their increased participation in the labour market. They talked about new opportunities in urban areas, rural towns and within the village. These findings are reflected in macro-level statistics. The participation of women in the employed labour force has been increasing in absolute and relative terms. According to official labour force surveys, the female share of the incremental increase in the labour force was 23% between 1983-84 and 1989, rising to 48% between 1989 and 1995-96 and rising again to 72% between 1995-96 and 1999-00. The female

labourforce growth has been fastest in the urban sector ; fueled by the rural to urban migration of a vast number of rural women looking for formal employment with a regular wage and more secure workers' rights(Jennings and Brush, 2013). In Bangladesh, the three most important sources of economic growth have been international remittances, readymade garment (RMG) exports, and crop production, and women are active in each of these sectors (although their participation has not always been highlighted)(Sultana, 2012) .

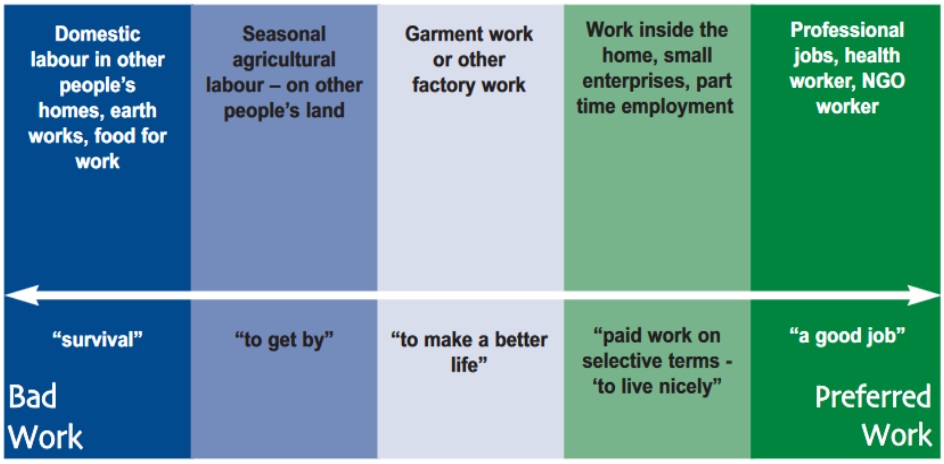
3.5 Women are Key Players in the Labour Market and are Therefore Key Actors in the Wider Economy

The participation of women in the RMG sector is well known. The RMG sector employs 1.8 million people, of which 80% are women. These workers work long hours and receive a small hourly wage. What is not much commonly known is the part that women have played in crop production. The sight of women working in the fields is increasingly common (Grown and Sebstad, 1989).They are taking on new tasks (such as harvesting operations) and are also meeting the rising demand for agricultural labour generated by the introduction of new – often more labour intensive – crops (such as horticultural crops).Also not well documented is the contribution of women to the remittance economy. Women working in the urban sector talked of how they sent some of their earnings back to rural areas – money that was often invested in sibling's education, a contribution to dowry or used for household consumption. The precise extent to which women are participating in international migration is not known, but they do participate. Remittances keep the rural economy ticking. They create demand for goods and services in the rural economy and often represent the most significant injection of financial capital into villages.

3.6 What Kind of Work are Countryside Women Doing?

Women in both countryside and city areas are undertaking more paid work, and most of them would like to have more opportunities to work. But paid work for women in rural areas is limited – especially work of the more desirable types, which require more education, better payment, and are considered 'respectable.' Figure 2 represents some of the most common types of paid work undertaken by women in rural areas and reflects women's descriptions of that work.

Figure 2 Not all work is equal: rural women's views



When asked what type of work they considered to be more or less desirable, rural women's and girls' answers were influenced by many forces, including rates of pay, number of young children, marriage status, educational levels, the range of local available opportunities, and whether the work was outdoors, inside, or within their own home. Consistency with local social norms was also important, although the idea of what was acceptable from women's work often changed when a small (but visible) number of women began 'unconventional' work. Opting not to work at all was considered desirable on the one hand, as it suggested that one had a 'good' husband who could single-handedly provide for the family. On the other hand, even this position was modified when more professional jobs were considered, and when even better-off women declared that there was almost always use for the extra income that they might be able to generate (Grown and Sebstad 1989).

3.7 Why are More Women Working?

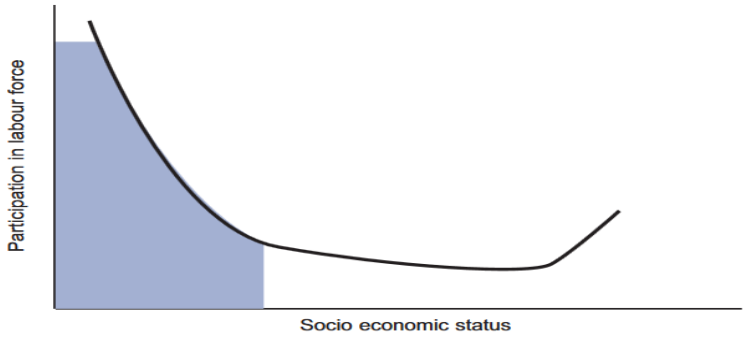
There are many reasons for the increased participation of women in the labour force.

3.7.1 Poverty is a Key Factor

Men's perceptions are that women do not need to work outside home if there is a male income earner in the household. Men also refer to situations where there are male earners, but income is inadequate to maintain the family. In these circumstances, men's general opinions are that it is acceptable for a woman to work to contribute to the household

income. The important point here is: men (and many women) justify women's work not for the sake of the woman's well-being, but for the welfare of the family. Thus men view women's participation in the workforce as supplementary. This perception partly explains the non-linear relationship between the participation of women in the paid labour force and the socio-economic status. This can be best described by a U-shaped curve: where paid employment in the workforce is high for the poorest women falls too low for those households who can manage on the income of a male earner, with participation widening at the higher end of the socio-economic spectrum were educated and better off women enter formal employment (Figure 3).

Figure 3 The U-shaped curve of labour force participation and poverty



Women in the middle of the socio-economic spectrum are an impressive group. They are less likely to be involved in paid work and are often not included in NGO programs. Many of those interviewed during the fieldwork did express a strong desire for incoming earning and employment opportunities. They want work that does not impact on the economy or compromise social and cultural values. The number of women who fall into this group is significant, and their fate is uncertain – some of them are likely to be surviving just above the poverty line. These women are more constrained by social norms. They are the followers of the status quo, while poor women are the breakers of the status quo. Poverty on its own however is not a sufficient explanation for the increase in the number of women entering the labour market as poverty rates have fallen slowly over the last decade and rates of severe poverty have fallen quite significantly.

3.7.2 There are Healthier Pairs of Hands

One key factor is the existence of a healthier female labour force. Women spoke of the improved health status of women today compared to women who joined the labour force a decade ago and compared to their mothers. The Human Poverty Index (HPI) supports this view. The HPI fell from 61% in 1982 to 40% in 1997, and furthermore, poverty rates as defined by human poverty fell relatively more quickly than those based on income or calorie-based measures. Both men and women gained from these improvements, but women gained more as gender disparities in both health and education dimensions narrowed. This macro-level picture was supported vigorously by women who expressed the following views:

- They are now less likely to die in childbirth, and their children are more likely to survive to adulthood
- They have smaller families and less time is needed to care for children
- There are more children in school
- Access to water and sanitation have improved
- Their awareness of hygiene and nutrition have improved
- They have better clothes for women and children and clean houses

All of the above translate into an increase in a healthier female workforce with more time on their hands.

3.7.3 Social Norms are Changing

Attributing participation in the labour force solely to poverty ignores the fact that changing social norms are also opening up space for women's work. Purdah is always being renegotiated as women do new things. It is the poor and most unfortunate women who are breaking socially constructed rules and norms relating to work outside the home. As economic pressures have increased, the poor have taken up new livelihoods –migration and employment in the RMG being the most notable examples. But there have been changes relating to employment within rural areas too.

3.7.4 A Day's Wage is not Sufficient to Maintain a Household of Three Even with year-round Employment

The situation is worst for rural women, where a year-round female wage does not support more than a family of two members. Even in urban areas,

women often work in the informal sector where wages are low, pay is irregular, and labour rights and working conditions dismal. A significant proportion of rural women are likely to spend all their working lives in a swamp of low-skilled, low productivity and low return activities.

3.7.5 Women Want to Make a Better Life

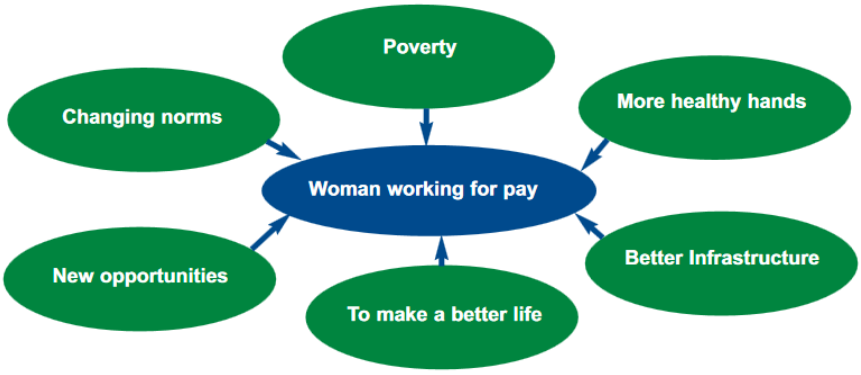
Women are also seeking paid employment in their words to 'make a better life.' For these women, work outside the home was not a prerequisite to making ends meet, or to lift the household out of poverty. Like people almost everywhere, but especially people who are living in a fast-changing society like Bangladesh, rural women are acutely aware of the goods and services that money can buy. When describing what they meant by a 'better life,' women told that extra money was intended for basics such as better clothes for the family, and for household improvements. But it also includes luxuries such as television sets, mobile phones, cosmetics, and furniture. Paying for educational expenses such as private tuition and exam fees was also a requirement for 'a better life,' and a common reason to seek paid employment.

3.7.6 Improvements in Physical Infrastructure are Making a Difference

Improvements in infrastructure have no doubt been a driving force behind increased migration by both men and women. This has apparently led to an increase in women working in urban areas. But a second effect has been the increase in female employment in the countryside as they take up the jobs either vacated by men or to fill the gap until remittances arrive. This was conspicuous in a village off the Rajshahi - Nawabganj highway, where men's seasonal migration often left women without enough money to run the household. Women then took up paid work in handicrafts or as domestic workers to make ends meet, until their husbands returned.

Thus in summary, there are a large number of reasons why, apart from demographic factors, women are increasingly undertaking paid work (Figure 4). Individual women's decisions to work or not to work are driven by a combination of factors, including health status, skill level, number and age of children, husband's income and attitude towards working women, and local norms. Adolescent girls' decisions about paid employment are quite complicated but are very much influenced by their parents' preferences. If the working girls live at home, their parents control the majority of their income.

Figure 4 Factors influencing women's decision to work



As described above, poor women have exploited the opportunities socially made available to them. They have created an institutional space for work and are waiting for new livelihood opportunities. It remains to be seen how much further they will go, and how quickly – when significant numbers of women will start operating power tillers, participating in the harvesting of paddy, or buying and selling in rural markets. Will social expressions of backlash against female workers in the form of stigma, resentment, harassment or violence constrain their progress?

3.8 The Consequences of Women's Occupation Selection

The expansion of the labour market for women and the changing mix of opportunities raise many questions. Are women doing the same work more or slowly peeping into men's domains? Are the options and opportunities opening up for poor women the same as those for poor men? If women are participating more in the lower end of the job market, does it mean that they have less chance of moving upwards? What are the consequences of women's occupation selection?

3.8.1 New Opportunities are Emerging

Today's reality is that rural households are often as likely to be involved in non-agricultural livelihoods as they are in farming, and increasingly derive their income from multiple sources. The number of small shops in villages has increased as have tailoring and other craft enterprises, rickshaw pulling and petty trading in villages in local bazaars. Women have been able to take advantage of some of these new opportunities. They have moved into new areas of employment such as participation in the horticultural production activities triggered by the construction of the

Padma Bridge and those jobs generated by the establishment and growth of the RMG industry. Microcredit has also led to income-earning opportunities for women. As men take advantage of new livelihood opportunities or migrate out of the village, women step in to fill the gaps. This is particularly the case of agricultural work. This finding is consistent with macro-level data which shows an absolute decline in male employment in agriculture during the second half of the 1990s (although of course, this decline may also be due to other factors such as changing cropping patterns and mechanization). This apparent 'feminization of agriculture' will have important implications for women both contributing to their practical needs (i.e., increased food security) and enhanced control of and access to, natural and other resources.

3.8.2 Women are Replacing Men in 'Men's Jobs,' but Men are Not Replacing Women in 'Women's Jobs

A good example of this was women in a peri-urban pocket of Gazipur District who undertake earthwork and digging. There is no gender gap regarding differential pay: men and women get the same wages for the same work. Twenty years ago female employment in digging was not as common as it is now. It is also now common to see some female agricultural workers conspicuously looking for work along with men in the spot labour markets of urban areas such as Savar and Dhaka.

3.8.3 There is a One-way Blurring of Boundaries

The pattern of the female labour force across the broad economic sectors of agriculture, industry, and services is starting to resemble that of their male counterparts. The female share in each of these main economic sectors increased in various degrees, the most in agriculture and the least in services. This represents a blurring of boundaries in the gender division of the employed labour force. The starkest blurring of boundaries has taken place in the agricultural sector although female participation is still limited to non-mechanical operations, the cultivation of minor crops and post-harvest operations. Most commonly, women were taking on agricultural tasks that are now seen as undesirable by younger men with some education. These men have clear ideas about what types of jobs their education and status entitle them to, and low-paid agricultural labour is not included in their vision as acceptable. For a household with working men and women, women's participation in agriculture can free up time for the adult male who may earn more in the non-agricultural labour market.

3.8.4 Human Dimensions of Change

Progress in the reduction of human poverty is visible in most rural areas of Bangladesh. These advances appear to have benefited women to a greater extent than men, possibly because they were lagging far behind men (this observation is supported by aggregate trends). Women spoke forcefully about the local manifestation of macro trends: 'we are less likely to die in childbirth, our children are more likely to survive into adulthood, we have sanitary toilets, clean drinking water, more awareness about hygiene and nutrition, better clothes for women and children, more decent houses and villages, and smaller families'. Access to primary, secondary, and tertiary education has increased for children, particularly for girls. These improvements in human capital are enjoyed by poor women, though perhaps less relative to the non-poor, but certainly more relative to their mothers. Thus, women are more likely to have a 'healthy pair of hands' than before. Similarly, mothers' expectations of their daughters' futures and girls' aspirations are dramatically different from a generation ago, and even from 5-10 years ago. These aspirations often had economic dimensions. Many girls who were still enrolled in secondary school expressed the desire for 'a good job,' but fewer were sure what a good job might entail. Some mentioned NGO worker or health worker; some said garment work. The non-economic dimensions of education were more strongly articulated by women who were beyond school age, particularly by the mothers of school-age girls. They spoke of education's value in helping a person to get by in the world, in being able to sign one's name, read road signs, and read medicine bottles. There was also a sense that girls needed education more than their parents to maintain the personal dignity and status within the community–'to speak nicely' 'not to be made a fool of.' Adolescent girls now regularly move outside the house and are seen in public, use public transportation, and study the same subjects as boys.

3.8.5 Social-cultural Dimensions of Change

Cultural changes are happening in both the urban and rural areas of Bangladesh. Poor women, particularly those from female-headed households, tend to be less constrained by social norms of what is acceptable women's work. Hence, they can (and must) participate in the labour force more readily than some better-off married women. They have access to public domains such as construction sites and roadsides. They can take up outside wage work in the village, migrate to urban areas or

even penetrate into 'male' jobs (shops, construction, low-paid agricultural work, and even some transport work). These women are the breakers of norms in society, helping to blur the distinction between men's work and reduce sex segregation in the labour market. 'Good marriage' was considered by all a pre-requisite to happiness but for many girls and their mothers, a good marriage was no longer considered enough. Mothers spoke of the need for economic opportunities for their daughters after finishing school. 'After completing their education, they can no longer sit idle, at home,' said one woman. In a survey of young garment workers in Dhaka, young women themselves reported that the two most significant benefits to working, often at relatively low pay and for long hours were the opportunity to contribute to their families' well-being and to be less of a burden on their families.

4. Complications of Women's Occupation Selection

4.1 There is Little Mobility in the Lower End of the Job Market

There are many reasons for the little mobility at the bottom end of the job market.

First, rural women have little bargaining power because their education level is low and they come from poor households. These factors (along with high unemployment and underemployment rates and the overall persistence of job segregation by sex) keep wages low.

Second, because of job segregation, women are not hired for field operations (particularly harvesting) of major crops. This is the highest paid type of agricultural work.

Third, skill constraints lock in female labour to the lower end of the job market. Some of them will find it almost impossible to escape their present work status. These are women who are older, have little or no education and are single with minor dependents.

Fourth, women with little or no assets are also less likely to make any transition from their present livelihoods pattern.

Thus women may now have healthier pairs of hands, but for many women, these hands are helping them more to survive than to thrive.

4.2 There are a Smaller Range of Options for Poor Women than for Poor Men

The range of choices for poor women is less than the range of choices for poor men. Low skill levels constrain both poor men and women, but poor men have greater mobility and security. For example, a poor man can go to deeper parts of the neighbouring forest to collect fuel wood but a woman cannot. There is also still a widespread perception that many jobs are 'men's jobs,' and therefore not appropriate for women. It is relatively unusual for a woman with a family of her own to have access to the range of migration opportunities available to men or younger women.

4.3 Security and Safety of Poor Women and Adolescent Girls

Rural ideas of the appropriateness for women of different modes of transport, distance traveled, and types of journeys undertaken are changing. Although the overwhelming picture is of increasing mobility and visibility for women and girls, there is an important caveat to this story. Women and particularly adolescent girls are the concern of deterioration in personal security and safety. This undoubtedly limits livelihoods options and choices (e.g., access to markets, wage employment and common property resources such as water bodies and forests).

4.4 Education Costs and Sexual Violence Affect Occupation Selection

Although the education programme is highly valued, girls and their parents reported problems involving its costs and quality. The most common concern was that the amount of the stipend was not sufficient to meet the costs associated with education – mainly supplementary private tuition. Again and again, stories were recounted of girls from the poorest families who dropped out of school in grade nine, just as they should have been preparing for the grade 10 Secondary School Certificate (SSC). It is at this critical juncture in secondary school that the need for supplementary private tuition is most apparent, and there was a widespread tendency for girls (and perhaps for boys) to drop out at this stage. While there is inherent value in school attendance for its sake, if girls are to have more control over their own lives, more options for the future, and to take advantage of their education, they need to be provided with the opportunity to complete grades 10 and 12. There are likely to be social costs for the poor women who are breaking the social-cultural norms. Prices may come in the form of increased exposure to criminal or sexual violence when moving outside the home; increased gender violence

within the home; or other forms of backlash. The relatively public nature of the field work did not allow the writer to explore sensitive issues such as the relationship between changing male and female identities and gender violence, and further work is needed to understand this dynamic.

4.5 Increasing Demand for Jobs

The growing number of girls participating in secondary school education is bound to have a dramatic effect on Bangladeshi society and, given a chance, will enable a large number of young women to take part in the formal economy. The psychological effects in communities and within girls themselves of girls 'increasing mobility, skill levels, and analytical capacity was evident in all of 11 villages visit. As more girls participate in, and (critically) complete their secondary school education, there will be an increased demand for jobs and opportunities represented in the upper rungs of Figure 2. Yet there is a real danger that possibilities for the girls and young women representing this 'ray of hope' are limited, if the private sector does not generate jobs, if the education system does not prepare them adequately, and particularly if efforts are not undertaken to ensure that women are provided with the opportunity to engage in 'men's work'.

4.6 There is Universal Concern about Dowry

Although dowry is illegal in Bangladesh, it is alive and the issue invariably came up in village discussions, and was the source of universal worry. There is widespread agreement that the size of dowry demand is increasing. The increasing burden of dowry is without question leading to financial pressures on girls and their families; some girls claimed to be saving towards their dowries, many families cited dowry as a major use of microcredit loans, and increasingly educated girls are seen to require 'better' (and more expensive) husbands. It is also bound to be a significant psychological impact on girls, who are always exposed to their parents' talk of the pressure of finding money for a dowry, and the seemingly public knowledge of each dowry transaction in the village. On the 'receiving' side, dowry may provide a temporary boom for young men and their families, and it may be that as young men increasingly take advantage of non-farm opportunities, they use one or more dowries to establish small businesses.

4.7 **Additional Work Costs Health Risks**

Relationships between changes in the economic, social-cultural and human capital realms may not necessarily be positive or reinforcing of

each other. Increased mobility, for example, has, in some cases, been cited as one of the reasons for the increasing concerns women have about their security. Women who take on paid work will suffer from additional work burdens, may face increased health risks and challenging decisions on childcare. Although the benefits of women's wages invariably accrue to the household, the costs of women's work are almost always internalised by the working women herself. Tekibari village is located 35 km from Dhaka, just 5 minutes from the main Gazipur road. Until a few years ago, the main activity of the households was puffed rice-making, with both men and women working on the homestead. However, the establishment of two factories nearby means this livelihood strategy is no longer profitable for many. Earth digging has replaced puffed rice making as the major economic activity. The work is hard and arduous; men and women work side by side from 7 am to 5 pm. Women are uncomfortable and embarrassed at working near men, particularly when lifting the earth onto men's heads. Times are even harder during the wet season, however, when digging work is not available, and households drop meals. Only a few children in the village attend school as many of the older children take on the burden of looking after the younger siblings while their mothers and fathers work.

5. Recommendations

- The government needs to reflect carefully on the emerging trends and plan. There is a role for NGO in working with government and the private sector to improve the participation of women in these important aspects of the economy.
- They also need to monitor the changing structure of the labour force and assess what this implies for male employment carefully.
- The government has to support poor girls who gain access to secondary school education but then drop out before critical exams. These could be scaled up with the support of the stipend system.
- Creative thinking is needed on how to deal with the increasing insecurity and violence faced by young women. And action can be taken to ensure that greater numbers of existing 'good' jobs are available for appropriately skilled young women graduates. Efforts of this kind represent an attempt to recognise realities and maximise the positive aspects of important changes.

- The government however can do little to change the fact that in any society – the and uneducated women will undertake the least rewarding jobs.
- Private sectors also can generate the massive growth of providing sufficient numbers of better opportunities for young, educated women and can do much to influence the quality of work available to poor women, and the number of better jobs available to the 'rays of hope.'
- NGO, private sector, government, and the donor should improve the health and safety standards, to ensure equal pay for equal work, to offer crèche facilities and to enforce and expand quota programmes that favour women and girls.

6. Conclusion

It is very much established that women and girls are affected by positive changes on many fronts. But these changes cannot be considered in isolation from each other. A change in one element of a person's livelihood will usually have the knock-on effects on other parts of their livelihood. Women and girls identified many examples of positive and reinforcing knock-on effects:

- Improvements in health lead to more healthy hands available for work
- Improvements in infrastructure allow for greater access to more rewarding, non-agricultural jobs beyond the village
- Access to education stretches social boundaries and establishes new norms
- Access to education delays the age of marriage

There may also be a time factor between the change in one area and a related change in another. The most notable example of this is the improvements in the educational status of girls which will, in the future, provide them with skills to enable them to take up new economic opportunities.

The views and voices of Bangladeshi women and girls were the foundation of this study, and their daily experiences and hopes for the future drive are the conclusions. It is discouraging to think of a vast number of women toiling away, often putting their health at risk and compromising their social status. But the fact remains that their increasing

ability to earn even a small amount of money improves their lives. Earthworks, road construction, and domestic service are examples of the kind of work to which poor women need continued access if they are to have a livelihood. Wishing that these sectors would disappear, or 'protecting' women from participating in this kind of work is not an option. The most prominent message of this study is the different prospects faced by the various groups of women and girls. The author has noted the differences between the poorest women and the rays of hope. But there are also issues to support the women in the middle, living just above the poverty level, who find it difficult to break social norms and enter the workforce and may represent tomorrow's poor. Supporting these groups will require different types of actions, but the key message is work is needed across the spectrum to ensure a better future for all women and girls.

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A Case Study of Birth Intervals in Bangladesh by Using Cox's Proportional Hazard Model

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Abstract

This research deals with a case study of the birth interval of Bangladesh using Cox's proportional hazard model. In this study the second birth interval is considered because if the second birth interval is higher, then the chance of getting more children is lower. This research also presents the present condition of the second birth spacing in Bangladesh and different demographic and socio-economic factors that affect the second birth spacing. It is found that the mother's education, the survival status of the 1^{st} *birth, the region, the place of the residence and the mother's age at marriage have a great influence for the variation of the second birth spacing.*

Key words: Birth Interval, Cox PH model, Hazard Ratio.

1. Introduction

Birth spacing (interval) refers to the time interval from one child's birth until the next child's birth i.e; length of the time between two successive births. Identification of the factors causing variation in the length of birth interval could be of great importance for it's direct relation to fertility.

The information on birth interval provides an insight into birth spacing patterns, which has far reaching impact on both the fertility and the child mortality level. The number of children a women may produce during her whole reproductive period depends on the length of intervals she gives between births. Thus for any woman, longer birth intervals imply lower level of fertility. Research has shown that children born too soon after a previous birth are at an increased risk of dying at an early age. Birth interval can influence fertility as well through an improvement in child mortality (Sharmin et al., 2003). Increased intervals between births have beneficial impact on children and infant mortality (Shaikh, 1997).

Differences in the country's fertility levels can be attributed to the differences in the length of the reproductive life of a woman and differences in the length of time between births when women are exposed to the risk of conception. Analysis of those factors influencing the span

and those affecting the spacing of fertility has proven useful, since in many causes they appear to vary quite substantially across population (Rodriguez et al. (1984)).

Different studies have examined these issues and identified different risk factors contributing to the length of birth intervals. Rodriguez et al. (1984) compared results of identical structure models for nine countries and found that a woman's education, age and previous child birth interval had substantial effects on the subsequent birth interval. Analyzing World Fertility Survey (WFS) data from Indonesia, Malaysia and the Philippines, Trussel et al. (1985), unlike Rodriguez et. al found that socio-economic factors do not have any independent effect on birth interval; rather, these factors mainly extend their influence through biological or proximate determinants of the birth intervals such as breastfeeding behavior, contraceptive use, coital frequency and induced abortion. The positive association between breast feeding and length of postpartum amenorrhoea is well documented from the experience of many countries (Chen et al. 1974). A study on child spacing in Asia by Rindfuss et al. (1984) revealed that ethnicity, age at birth and urban experience have a substantial effect on birth spacing.

Despite the importance of birth interval, only a very few studies have so far been carried out in Bangladesh to investigate the risk factor associated with birth spacing and its relation to other demographic phenomena, those that do deal with typical data and do not represent the whole country. Different studied have examined these issue and identified different risk factor contributing to the length of birth intervals. Zenger (1993) studied siblings' neonatal mortality risk and birth spacing in Bangladesh. Chakraborty, Sharmin and Islam (1996) studied the differential pattern of birth interval in Bangladesh utilizing the 1989 Contraceptive Prevalence Survey (CPS) data and assessed the contribution of some selected demographic and socio-economic characteristics to the variation in the length of birth interval. A similar type of analysis is carried out by Sharmin, Zainab, Bari and Islam (2003) utilizing the 1996/97 Bangladesh Demography and Health Survey (BDHS) considering the same explanatory variables that were used in Chakraborty et al. study in 1996. They found that the mother's age and the survival status of the index child during infancy and early childhood has been found to be strongly related to a shorter subsequent birth interval. A study conducted by Mahmood and Zainab (2011) utilizing the 2004 BDHS data, they have found that the mother's education, her age and place of residence have a

great influence for variation in birth interval in Bangladesh. Some of the works concerning the birth spacing are mentioned hereby, such as Cleland and Sathar (1984) described the effect of birth spacing on child mortality in Pakistan. Mahumder, A.K. (1990) studies on the child survival and its effect on mortality of siblings in Bangladesh.

2. Literature Review

Survival analysis is a collection of statistical procedures for the data analysis for which the outcome variable of interest is time until an event occurs. The objectives of survival analysis include describing lifetimes of a single population or may be to compare lifetimes of two or more groups of subjects by using different treatments and a comparison between the lengths of survival time of each subjects can be used to measure the effectiveness of one treatment over the other. The term survival data refers to the length of time that corresponds to the time period from a well-defined starting time to until the occurrence of some or more events or lost to follow-up or the end of the study period. In survival analysis using the event is referred as failure, but the term is also used for the event like diagnosis of interest of a disease or a complication. In these cases the typical start time is when the patient first received the treatment and the end point is when the desired event for the patient occurs or was lost to follow up. Survival data can take so many different forms such as censored, uncensored repeated events, multiple states, clustered etc. Censoring occurs when we have some information about individual survival time, but we do not know the survival time exactly. Censoring is a mechanism for which the survival data are different from the usual data.

Most often, we tend to modeling approach to describe the situation so that it produces results that are statistically interpretable. To make the proper inference and interpretation, one needs to make an assumption about the distribution of survival times. However, the specification of a proper distribution is not easy due to presence of censoring. Censoring is the distinctive part about survival data, which sometimes makes us unable to use the standard procedures of statistical analysis directly. Conventional assumptions like normality are not appropriate for most of these cases. Also, specification may also be an unnecessarily stringent assumption to make. Therefore, we need to search for non-parametric or semi-parametric approaches to handle such data. During 1900s, there had already been a flourishing literature on the life table made for actuarial purposes, to describe mortality experience as documented by Oakes, (2001). But those

techniques were not adequate for advanced statistical analysis. The works of Kaplan and Meier (1958) and some of their successive developments (Efron, 1967; Breslow and Crowley, 1974; Koziol and Green, 1976) made it possible to find a non-parametric maximum likelihood estimate of a distribution function from the censored data and derive some of its superior properties.

Cox (1972) proposed an imaginative methodology that keeps us free from making any specific distributional assumption, still enabling us to bring out the estimates of the regression coefficients from the linear like model for the log hazards. This is a generalization of the method proposed by Kaplan and Meier (1958) that are additionally able to assess the covariate effects. As the hazard function clearly captures the essence of a lifetime process, exploring the dependence by incorporating the hazard function, it the most natural way to deal such models. In the basic model, hazard function is split in to two basic components: one is the baseline hazed function that may change over time but independent of the covariate effects (the functional form of this can be unspecified); and the another is some form of covariate function that characterizes how the covariates influence the hazard function (most often this function is constrained to provide non-negative values). This model is also termed as Cox's proportional hazards model due to the fact that hazard functions are assumed to be multiplicatively related in the original model. As a consequence of this assumption, the hazard ratio becomes constant over the survival time. This is because the hazard ratio is independent of the survival time; it only depends on the values of the covariates. Once we compute the regression coefficient estimates the covariates, we can then get a reasonable estimate of the baseline survivorship functions and hence estimate the baseline hazards.

Once the baseline hazards are estimated by Cox's regression model, for given values of the covariates, the hazard function is thus completely specified which is evident from the basic Cox's proportional hazard model. As a consequence, we can say that the underlying distribution of the survival time, for the given covariates, will be the of the same parameter. Therefore, conventional Cox's model assumes that the investigated subjects under given experimental conditions are independent and identically distributed, and hence, homogeneous by nature.

There may be situations, however, where there may exist some factors, other than the measured covariates, that may significantly

influence the parameters and hence modify the distribution of the survival time. There may be various reasons for such unmeasured or neglected covariates: if there are too many covariates to consider, it is nearly impossible for the researchers in practice to include all the relevant covariates. Then they are tempted to overlook some of the relevant covariates due to convenience of data collection procedure (for efficiency, time, and resource purpose; or simply due to the lack of appropriate tool to measure). Even if we take all possible known factors into account, a different sort of problem encounters: then the model is over-determined and the estimation of all regression coefficients are not possible in the usual procedure any more. Another common reason may be; researchers are not aware of the influence of the potential covariate that might exist. For example, if there is a genetic risk factor responsible for potential occurrence of some diseases, which may be unknown to us, it is not possible by the researcher to include that as a covariate. Such covariates are said to be the unobserved covariates. No matter how much covariate we want to add, it will never be the complete one, especially in the human studies.

3. Objective of the Study

In our study, we are trying to analyze the data for finding the pattern of birth interval. Here we use the birth interval data extracted from BDHS 2014. The covariates involve some key determinants for birth interval.

We first fit Cox's proportional hazards model with the help of BDHS 2014 data and get the estimates and corresponding standard error of the regression coefficients. Then we propose an appropriate model. The objectives of this study are:

- Assessing the factors involved in birth interval.
- Estimating the parameters of the Cox's proportional hazards model for birth interval.
- Estimating the parameters of the appropriate model for birth interval.

4. Methodology

Cox regression (0r proportional hazards regression) is the method for investigating the effect of several variables upon the time a specified event takes place. In the context of our outcome, birth interval, this is known as Cox regression for survival analysis. The method does not assume any

particular "survival model" but it is not truly nonparametric because it does assume that the effects of the predictor variables upon survival are constant over time and are additive in one scale. The coefficients in a Cox regression relate to hazard; a positive coefficient indicates a worse prognosis and a negative coefficient indicates a protective effect of the variable with which it is associated. Secondary data extracted from the Bangladesh Demographic and Health Survey (BDHS) conducted in 2014 under the authority of the National Institute for Population Research and Training (NIPORT) of the Ministry of Health and Family Welfare has been used for this study.

In this study, birth space between two babies taken as a dependent variable and a continuous variable is considered. The 2^{nd} birth after 2005 is considered for showing the current pattern of the 2^{nd} birth space, the 1^{st} birth has been any time. Though the censoring here is considered random but there is no interest about censoring distribution, so censoring is considered as type one censoring. In type one censoring the exact failure time is random and the censoring time is fixed. Here the highest birth spacing is 241 months, so for the censored data birth spacing 241 months are taken.The important demographic and socio-economic factors have been identified as explanatory variables on the basis of the previous studies. They are the mother's age at marriage, the mother's education, the mother's working status, wealth index, region, place of residence, religion, the gender of the 1^{st}child and the survival status of the 1^{st}child. The covariates may play some key role to the second birth spacing.

In this study the Cox proportional hazard model is used. The Cox proportional hazard (PH) model is one of the popular models that describes the relationship between the risk factors and the survival time. The Cox model is based on a modeling approach to the analysis of the survival data. The purpose of the model simultaneously explores the effect of the risk factors on the data. The proportional hazard model belongs to a family of hazard-based generalized linear regression models in which the conditional hazard function of the failure time T will be as below:

$$h(t; x) = f[h_0(t), \beta c(x)];$$

where $h_0(t)$ is an arbitrary baseline hazard function for an individual, i.e., the hazard function in the absence of covariates and c(x) be a known function of x that contains parameters of interest. A proportional hazards family is a class of models with the property that different individuals have

hazard function which are proportional to one another. That is, if $h_1(t)$ and $h_2(t)$ are the hazard functions for two individuals with covariate vector x_1 and $x_2$respectively; then the ratio of these two hazard functions does not vary with time t. This implies that the hazard function of T given x can be written in the form,

$$h(t; x) = h_0(t)\, c(x)$$

where $h_0(t)$ is an arbitrary baseline hazard function for an individual, i.e., hazard function in the absence of covariates and c(x) be a known function of x that contains parameters of interest. Under this model,

$$\frac{h_1(t; x_1)}{h_2(t; x_2)} = \frac{h_0(t)c(x_1)}{h_0(t)c(x_2)} = \frac{c(x_1)}{c(x_2)}$$

which is independent of time.

In 1972 Cox proposed the most popular and flexible proportional hazard model where the hazard function at time T for an individual with covariate vector x is given:

$$h(t; x) = h_0(t)e^{(x\beta)}$$

Research on the statistical analysis of survival data began in the mid-1970s with papers by Clayton (1978) who proposed a bivariate hazard model that can be interpreted in terms of a proportional hazards model with a gamma-distributed random effect, and Holt and Prentice (1974) worked with survival analysis in twin studies. Clayton and Cuzick (1985) proposed the multivariate generalization of the proportional hazards model. Hougaard (1986) also worked with multivariate survival models for heterogeneous population.

Results and Discussion

Table 1: Univariate analysis of exploratory variables .

Covariates	Frequency	Percentage
Child's sex		
Female	2680	48.60
Male	1920	51.40
Region		
Dhaka	645	11.70
Barisal	993	18.00
Chittagong	931	16.90
Khulna	792	14.30
Rajshahi	754	13.70
Rangpur	767	13.90
Sylhet	638	11.60
Place of Residence		
Rural	3600	65.20
Urban	1920	34.80
Mother's Education		
No education	561	10.20
Primary education	1467	26.60
Secondary education	2876	52.10
Higher education	616	11.20
Wealth Index		
Poor	1941	35.20
Middle	1092	19.80
Rich	2487	45.10
Mother's Working Status		
No	4921	89.10
Yes	599	10.90
Survival status of 1^{st} child		
Death	285	05.20
Alive	5235	94.80
Religion		
Other	624	88.70
Islam	4896	11.30
Censoring Status		
Censor	2843	51.50
complete	2677	48.60

Table 2: Parameter estimates, standard errors (SE), p-values and hazards ratio(HR) obtained from Cox's proportional hazard model.

Covariates	Estimate	SE	p-value	HR
Child's sex				
Female	.....	.....	.....	.....
Male	-0.037	0.021	0.712	0.897
Region				
Dhaka	.....	.....	.....	.....
Barisal	-0.045	0.036	0.758	0.752
Chittagong	0.663	0.098	0.000	1.702
Khulna	-0.059	0.047	0.479	0.561
Rajshahi	-0.035	0.058	0.687	0.598
Rangpur	0.034	0.072	0.640	1.034
Sylhet	0.405	0.072	0.000	1.497
Place of Residence				
Rural	.....	.....	.....	.....
Urban	-0.279	0.083	0.001	0.950
Mother's Education				
No education	.....	.....	.....	.....
Primary education	-0.210	0.084	0.204	0.815
Secondary education	-0.575	0.072	0.001	0.789
Higher education	-0.378	0.095	0.000	0.685
Wealth Index				
Poor	.....	.....	.....	.....
Middle	0.005	0.074	0.978	1.502
Rich	0.040	0.055	0.485	1.041
Mother's Working Status				
No	.....	.....	.....	.....
Yes	0.112	0.056	0.057	1.121
Survival status of 1^{st} child	.....	.....	.....	.....
Death	-1.026	0.071	0.000	0.358
Alive				
Religion				
Other	.....	.....	.....	.....
Islam	0.098	0.075	0.735	1.841
Age at marriage				
Linear Effect	-0.274	0.072	0.010	0.748
Squared Effect	214.002	0.003	0.356	0.005

$SE_{StandardError}$, $HR_{HazardRatio}$, ... $indicatesthereferencegroup.$

Table 1 shows the univariate analysis of exploratory variables which gives the frequencies and percentage of respondents for different categories.

Table 2 result shows the hazard ratio of different variables. From this table it is seen that the maximum hazard rate is shown for Sylhet and Chittagong region, that is the 2^{nd} birth space is higher in Sylhet region 1.497 times and in Chittagong region 1.702 times compared to Dhaka and others divisions differ insignificantly with Dhaka. Urban areas have 0.950 times lower the 2^{nd} birth interval than rural areas. It is also observed that if the previous child is alive then the birth space is 0.358 times lower compared to survival status of the 1^{st} child is dead. For the mother's education, secondary and higher educated mother's the 2^{nd} birth space is respectively 0.789 and 0.685 times lower than the non educated mother's but the birth interval for the primary educated mother's does not differ significantly with non educated mother's for this data set.

Variable mother's age at marriage is found statistically significant at 1% level of significance, from the following table it is found that the linear effect and square effect for the mother's age is respectively -0.274<0 and 0.003>0 which indicate that with the increase of the mother's age at marriage birth spacing decreases up to a particular level of age at marriage, after that birth spacing increases with the increase of the mother's age at marriage.

With respect to Table 1 the gender of the 1^{st} child, religion and wealth index are found statistically insignificant. This study evaluated the current effect of some selected demographic and socioeconomic variables on the subsequent birth interval using 2014 BDHS data and studied the strength of association between birth intervals and its various risk factors using Cox's proportional hazard model. Among the 9 explanatory variables examined, the mother's education, survival status of the 1^{st} child, region and place of residence were found to have strong impact on the 2^{nd} birth interval.Normally educated women always have a longer birth interval than non-educated women but this result shows that secondary and higher educated women's 2^{nd} birth interval is shorter than that of non-educated women.

Urban mother's have smaller birth intervals than that of their rural counterparts which indicates the lack of development in fertility behavior among the rural families; still they are not aware of high parity progression. Chittagong and Sylhet divisions have larger 2^{nd}birth interval

compared to Dhaka which means that they are aware about fertility behavior. Other divisions differ insignificantly with Dhaka. The result also shows that if the 1^{st} birth was dead then the 2^{nd} birth interval increases; it may be because generally a baby dies for the mother's complicacy on pregnancy; so mother's wait for their recovery. Thus the 2^{nd} birth interval increased. Determination and identification of the factors causing variation in the length of birth interval is of great importance for its direct relation to fertility. Though fertility is on the decline in Bangladesh but for achieving the targeted level of socio-economic development, it is still a problem. For achieving replacement level fertility in near future a rapid reduction in current fertility trends should be found.

In our study we have observed the association between the birth spacing and the mentioned explanatory variables. The results are given in Figure 1.1 to 1.8. Log rank test is performed for testing the significance of association. It can be presented in Figure 1.1 that birth spacing varies consistently among the region as indicated by the product limit method, which is significant (p-value = 0:000) at 0 percent level of significance. From Figure 1.2 we can say that birth spacing varies substantially among the place of residences as indicated by the product limit method, which is significant (p-value = 0:000) at 0 percent level of significance.

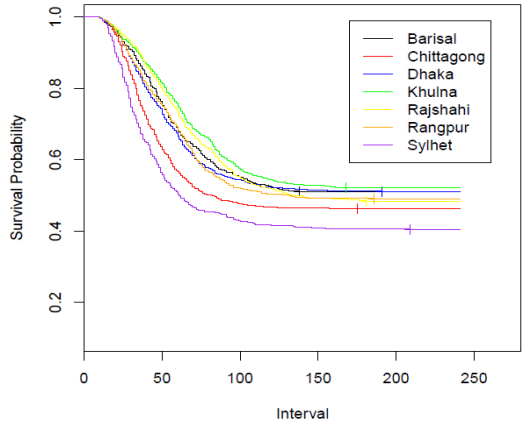

Figure 1.1: Plot of survival curves for different categories of regions (p-value =0:000).

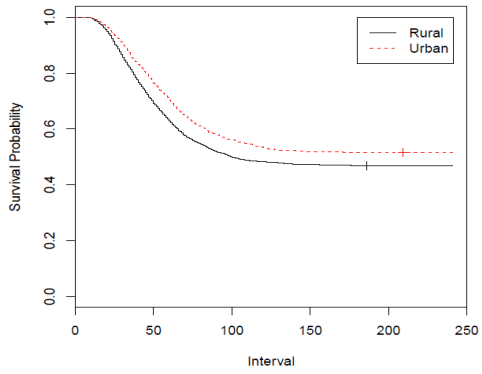

Figure 1.2: Plot of survival curves for categories of place of residence (p-value = 0:000).

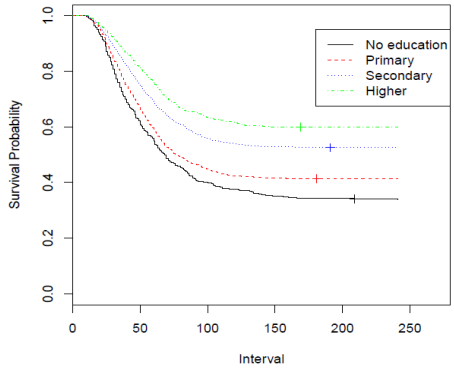

Figure 1.3: Plot of survival curves for different categories of mother's education (p-value = 0:000).

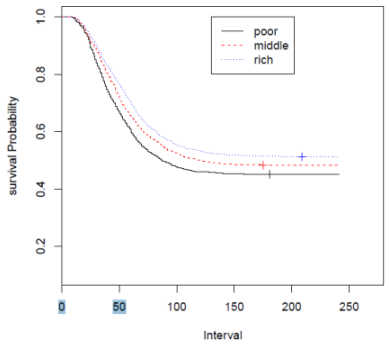

Figure 1.4: Plot of survival curves for categories of wealth index (p-value = 0:000).

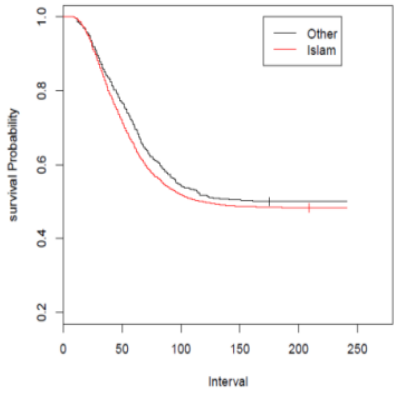

Figure 1.5: Plot of survival curves for categories of religion (p-value =0:190).

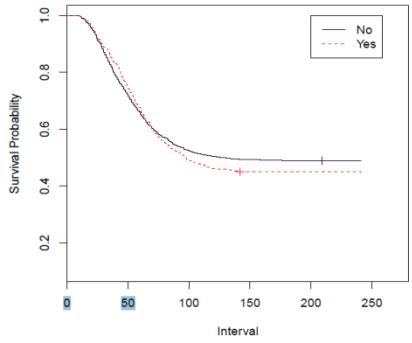

Figure 1.6: Plot of survival curves for categories of mother's working status (pvalue = 0:258).

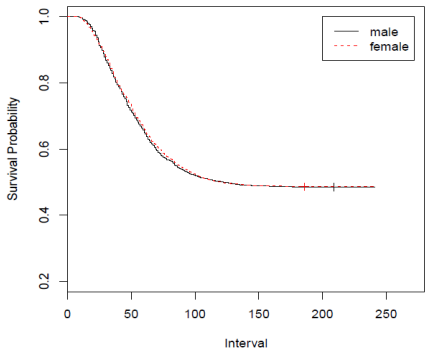

Figure 1.7: Plot of survival curves for categories of gender of the 1st child (p-value = 0:747).

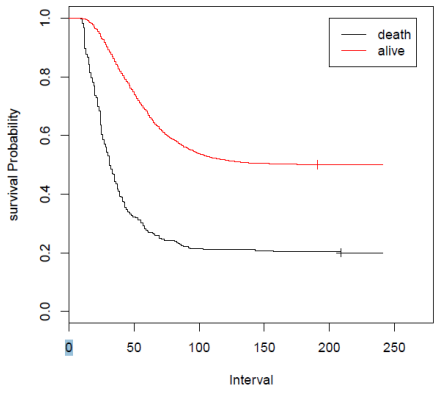

Figure 1.8: Plot of survival curves for categories of survival status of the 1st child (p-value = 0:000).

It can be said that, (From Figure 1.3) among the mother's education level which is indicated by the product limit method, is significant (p-value = 0:000) at 0 percent level of significance. With regard to Figure 1.4 we can interpret that birth spacing differs among the wealth index as indicated by the product limit method, which is significant (p-value = 0:000) at 0% level of significance.

On the basis of Figure 1.5, 1.6 and 1.7 we can conclude that the birth spacing differs among categories of religion (p-value=0:190), mother's working status (p-value= 0:258) and gender of the 1st child (p-value=0:747) insignificantly indicated by product limit method at 10% level of the significance. From Figure 1.8 we can say that birth spacing varies substantially among the levels of the previous child alive status as indicated by the product limit method, which is significant (P-value = 0:000) at 0 percent level of significance.

5. Conclusion

The accustomed endeavor of survival analysis is to examine the consequence of covariate information on time-to-event data. Occasionally, the actual distribution of the event time, as characterized by the baseline survival function or the hazard function, is of curiosity too. In most of the cases, the observed times are right censored, which imposes complications. Further impediment takes place when the observations are not independent, for example, when the subjects are from the same family/group.

We analyze the data using Cox proportional hazard model because we want to measure the effects of covariates on birth spacing by fitting the statistical regression model with the use of hazard function.

A similar type of analysis is carried out by Sharmin, Zainab, Bari and Islam (2003)utilizing the 1996/97 Bangladesh Demography and Health Survey (BDHS) and considering the same explanatory variables that were used in Chakraborty et al. study in 1996. They found that mother age and the survival status of the index child during infancy and early childhood has been found to be strongly related to a shorter subsequent birth interval. In this paper we found that survival status of the 1st child, mother's education, region are statistically significant at 0 percent level of significance. In variable mother's education secondary and highly educated mother's differs from the non educated mother's, primary educated and non educated mother's are similar. In variable region, Chittagong and Sylhet differ from Dhaka but Barisal, Khulna, Rajshahi and Rangpur are similar with Dhaka. Places of residence are statistically significant at 0.1 percent level of significance. The mother's age at marriage is significant at 1 percent level of significance. The mother's occupation is significant at 5 percent level of significance. The 1st child sex, religion and wealth index are found to be statistically insignificant at 10 percent level of significance. In Cox proportional hazards model we avoid cluster effect.

While conducting this study, we faced some problems during calculation, which lead to some limitations of this study. For example, The data was stratified by residence, i.e. the respondent were categorized as residing in rural and urban areas. This stratification was ignored in this study. This gives an idea about the child second birth spacing scenario in Bangladesh but to have the real scenario, the full data analysis should be done. Here we consider only the 1st birth spacing, differential pattern of birth spacing will be carried out. Another shortcoming was that individuals having missing observations were discarded from data. If the 2nd birth is before 2006 then the observation is omitted. So further research of birth spacing for Bangladesh can be carried out by overcoming these limitations.

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An Approach to Predict Students' Performance by Combining Data Warehouse and Data Mining Technique

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Atanu Shome

Abstract

One of the alarming situations in today's education management community is the failure rate among the school, college and university students. In 2013-14 sessions the drop rate for UK universities stood up to 6% [Source: Higher Education Statistics Agency]. Many researchers are trying to discover the reasons behind these bad performances. Analysis on the students' performance could help the higher education community to identify the reasons for dropouts and bad performances, and also to help take necessary measures. The aim of this paper is to create a data warehouse using different data mining techniques to evaluate the student's academic performance. All universities will keep a storehouse of student records and the global data warehouse will be built upon these storehouses. Data mining is the process of finding the meaningful information from the data warehouse and also analyzing the correlation between the variables of the data warehouse. It is possible to create a student data warehouse using their academic information which comprises academic result, personal information, semester information, disciplinary actions, and student's activity. Data mining algorithm can be applied on this data warehouse to develop a warning system which calculates student's future successes and also finds out the reasons that affect their successes.

Keywords: data collection, data warehouse, data mining, classification, prediction

1. Introduction

Academic failure is one of the most worrying situations in today's education management committee. As we know that the main asset of an educational institution is the students so they represent their university by their academic achievement. But students' dropout rate and the poor academic performance are increasing day by day. Many researchers try to find out the reasons behind this situation (Parmar et al., 2015; Mbugua et al., 2012; Piatetsky-Shapiro & Gregory, 1991; Pradeep, Das &

Kizhekkethottam, 2015). Most common reasons are the rules and regulations set for academic results, university's environment, the choice of wrong program and the concerned teachers. Other possible factors such as the family, environment, and class hours may also affect the students' academic performance (Osmanbegović et al., 2012). A university produces high quality graduates with great academic achievements. Academic performance among the students is usually recorded in different ways such as files or documents or in a software etc. The real fact is that there is a significant growth of educational data in the educational institutions. Analysis of these increasing numbers of data is getting difficult. Data mining applications come to perform a great contribution to overcome this difficulty (Göker et al., 2013). An automated system can be created using data mining technique to predict the students' performances that could be useful in many ways for the education management committee.

Students' academic information, state, family, absenteeism are mainly stored in the students' database (Ahmed et al, 2014). Valuable information is hidden in this database although the database size is huge. By analyzing this information it is possible to find out how they learn. In order to improve the efficiency of these institutional education and provide a shape for future education policies, take necessary steps and give better suggestion for the students according to their academic performance etc. institutions need a storehouse. A student data warehouse can be built in this storehouse. It is needed to extract the important information from the student data warehouse. For this purpose, data mining technology can be applied on this student data warehouse to find out the valuable knowledge. Creating a storehouse, designing a student data warehouse, applying data mining techniques on this data warehouse –all of these contribute to improve the education quality. Analyzing the education data of a university in a digital environment, it is possible to extract the valuable information for the betterment of the students and it is of great importance concerning the student's future career. For this purpose to store the useful information about students, a storehouse is of immense importance. The academic achievement of students is the average success of each courses of the program. Not only the result can represent academic success or failure, there are many factors which indicate student's success or failure.

The purpose of this paper is to study how to accomplish the data mining method by using data warehouse in order to predict the students' performance (result, retain, discipline etc.) as well as see the students'

progress, behavior, attendance of every registered course by analysing the storehouse of a university. The university authority can easily observe the students' progression through data mining technique. By analyzing it, the university authority can take necessary actions or give appropriate suggestions to students whose progress is not satisfactory. The number of possible dropouts, poor results holders etc. could be reduced after taking proper action and the standard of education as well as the reputation of the university can be raised. In this research, we discuss how data warehouse and data mining technique can be applied in a university to increase students' academic performance.

2. Existing Research

Student performance prediction has been the subject of research for many years now (Mbugua et al,2012; Ahmed et al., 2014; Parmar et al., 2015; Kurniawan et al., 2013). It ensures a student's bright career and shows the overall growth of the educational measurements. Thus many researchers were interested in student performance analysis from time to time. And many of them choose data mining technique to create a meaningful conclusion regarding the student performance from the huge piles of data (Ahmed et al, 2014; Göker et al., 2013; Parmar et al., 2015). Data mining involves artificial intelligence, machine learning, statistics, and database systems in order to find patterns among data (Hastie, Tibshirani& Friedman, 2009; Witten, Frank, Hall & Mark, 2011; Law, 2016). Its goal is not only extracting meaningful information from data stack, it also works for data pre-processing, inference, complexity considerations etc. Analysing data from different dimensions is hard when the amount of data is huge, but data mining brings out the effective steps to do it efficiently (Liu & Bing, 2007).

Osmanbegović et al. (2012) concentrated on students' success rather than students' bad performances. They analyze the students' socio-demographic variables, achieved results from high school and from the entrance exam, and attitudes towards studying which can have an effect on the success. It is clear that environmental and behavioral factors can impact the students' performance. Their tests were conducted using footrests for the assessment of input variables: Chi-square test, One R-test, Info Gain test and Gain Ratio test. The results of each test were monitored using the following metrics: Attribute (name of the attribute), Merit (measure of goodness), Merit dev (deviation, i.e. measure of goodness deviation), Rank (average position occupied by attribute), Rankanddev (deviation, deviation takes

attribute's position). They applied three algorithms into their dataset: Naive Bayes, Multilayer Perceptron & J48 algorithm. The results indicate that the Naïve Bayes classifier outperforms in prediction decision tree and neural network methods.

Ramaswami & Rathinasabapathy (2012) used Bayesian networks for performance prediction. They have considered 35 socio-economic and academic factors such as family income, no. of brothers and sisters, food habit etc. Now while these types of factors may affect the performance, but some of the factors might overload the prediction process due to lack of necessity. It may turn into overhead for the data storage size. Similarly Göker et al. (2013) worked on the academic success of students for local institution not in a global scale. Using the data warehouse concept they gathered information and upon which they applied the feature selection algorithms. It was concluded that in the estimation of students' academic success a large portion of it (85%) could be explained with the features in the student data warehouse. They found Naïve Bayes is the best fit for their data. They focused on only students of 9^{th} level and the analysis was performed on 9^{th} level results only. This reduces the scope of getting proper analysis as factors affecting student performance can change during the student's academic life from one level to another level. A 5^{th} level student might not be open to drugs but a 10^{th} level student might be.

Kurniawan et al. (2013) introduced data warehouse with data mining for the student performance analysis. A data warehouse is a data set that is subject oriented, integrated, time variant, and nonvolatile to support the decision making process (Inmon, 2005). The purpose of this research is to learn how to implement the data mining techniques through data warehouse to forecast for students progression status (progress, retain, conditional progression) by analyzing data and to see the influence on the student's grades, behavior and attendance of students for progression status on BINUS International School students using data mining application (predictive modeling technique). They use star schema to modeling the data warehouse to support the data mining analysis and the star schema describe the fact table surrounded by the dimension tables. They use this schema to facilitate the process of defining the query time of the report formation. Data warehouses store data from several sources which might be of different kinds in nature and allow analyzing those data for creating critical reports / pattern recognition. Y. Kurniawan et al. used this data warehouses to device a prediction model, but again in local data. They did not focus on the factors rather they focus on the performance

predictions. Parmar et al. (2015) worked on a decision support system that analyses the local data and generalizes rules for global models. They have used distributed data mining (DDM). They applied the algorithm Random tree onto the local datasets and finally applied on the distributed sets to create a generalize model. Random tree gives higher accuracy compared to other decision trees (Piatetsky-Shapiro et al., 1991).

In this paper, a data warehouse was designed to see the students' academic information. Several decision tree classification techniques were applied over the extracted attributes from the data warehouse to predict the performance. WEKA machine learning tool was used for analyzing the dataset. Finally a classification model was designed that helps us find those students with poor grades and factors that caused this bad performance.

3. Methodology

There are several steps to implement this methodology. Steps consist of data collection, data processing, data warehouse design, decision tree classification and finally prediction. In data collection part, student's related data are collected for mining. Missing value, noisy data are handled in the data pre-processing part. After pre-processing, a data warehouse is to be designed. Decision tree induction is used as classification method for this methodology and finally prediction as a result of this system.

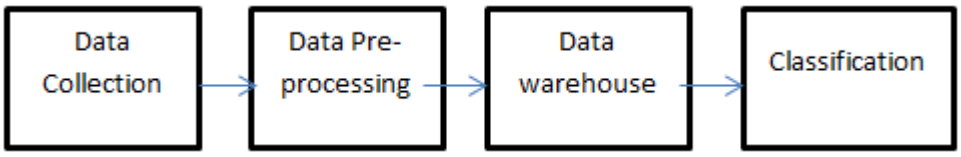

Figure 1: Data mining process to predict student performance

3.1 Data Collection

In the data collection steps, information about the students' different activities are to be collected. We collect the following information to form a storehouse and data warehouse.

I. Attended Semesters: Collect information about list of semesters attended by a student with semester GPA (SGPA) and cumulative GPA (CGPA).

II. Discipline: Collect information if any disciplinary action was taken against a student.

III. Semester Result: Record of each semester result with the grade of registered courses.

IV. Attendance: Keep attendance records for every student course-wise.

V. Class Evaluation marks: Class evaluation marks is the combination of class test marks, and quiz test mark. Keep records of all marks of each individual course.

VI. Assignment or presentation: Keep records of assignment marks of each individual course.

VII. Students Activity: Record of different activities participated by students excluding academic information.

3.2 Data Pre-processing

There are a few matters like data may be missing or noisy etc. that are solved in this phase. To solve the missing value or to correct dirty or noisy data, we can use SQL commands. Apply the following procedure in the data pre-processing steps

I. Some categorical data like students email, phone or address may be missing. Those categorical data does not affect the performance so much. To solve this, use a global constant like "UNKNOWN" where these types of data are not present.

   Update Email set email= "UNKNOWN" where email = "NULL"

II. Some important data like class test, mid-term marks may not present due to mistakes of the course teacher. To solve this problem, use average marks of the related courses.

   Update classTest set classTest = Avg (classTest (course)) where classTest = "NULL"

III. Every data has an upper value and marks cannot be negative. Give any marks that are greater than the upper value or negative may be considered as noisy value. Set NULL value to avoid this situation.

3.3 Data Warehousing

Data mining techniques are used to explore the valuable information from the existing data in data warehouse. Information like students attendance status, score (mid test, class test, quiz test, assignment), discipline systems, other activities were collected from the web based system to forecast the students performance at the end of the semester [Kurniawan and Halim, 2013]. By analyzing student data in a digital environment, the extraction of valuable information for the future of the students is of great importance in planning the future of their lives [Göker et al., 2013]. For this reason, provision of this useful information on student data warehouse is important. Figure 2 describes the fact constellation schema of modeling the data warehouse at a particular university.

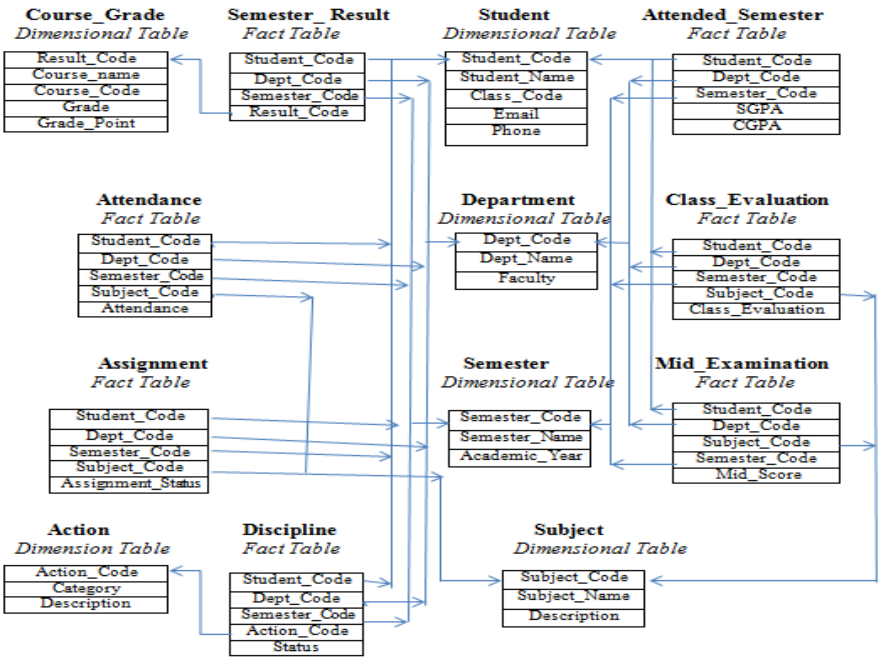

Figure 2: Fact Constellation schema of a data warehouse for students

We use a fact constellation schema to design the data warehouse. Fact constellation schema contains multiple fact tables and the dimensional tables to be shared between fact tables. It splits the original star schema into more star schemes and each of them describes facts on another level of dimension hierarchies.

3.4 Classification

Classification is used to discover and extract knowledge from a dataset. It permits building a classifier model based on training data, testing this model on the test data and using it in order to realize predictions [Robu and Hora, 2012]. Classification is a basic task of supervised learning in the data analysis that need for the construction of a classifier, in this function, a class label is assigned to instances described by a set of attributes [Parmar et al., 2015].Among different classification techniques, decision tree induction is very popular because it does not require any domain knowledge and can handle multidimensional data (Han, Kamber, and Pei, 1998). It provides an easy way to produce the classification rules from a decision tree that is a good way to represent information or knowledge. A decision tree is a flowchart-like structure, where internal nodes denotes a test on an attribute, each branch represents an outcome of the test, and each leaf node holds a class label while a topmost node in a tree is the root node (Han, Kamber, and Pei, 1998). Decision tree has the following phase

i. Building phase
ii. Pruning phase

The building phase generates a tree that correctly classifies each data from the training set. Pruning phase is performed after the building phase in which trees are iteratively pruned by halting its construction and to generate a tree with better accuracy.

3.4.1 Data Mining Process

In today's education in the university, students' performance is ascertained by the attendance, the class evaluation, the assignment, the midterm examination, and the final examination. Each student needs at least 40 percent marks to pass a course.

A. Data Selection and Transformation

Student's data warehouse contains a lot of academic information about the students. In data selection step, only relevant informations are extracted from the data warehouse needed for mining. In order to predict a student's final result in a particular course, it is required to import the following components listed below for analysis:

i. CGPA
ii. Attendance Marks

iii. Class Evaluation Marks
iv. Assignment Marks
v. Midterm examination Marks
vi. Final Result

We chose these attributes because these are directly related to education and have impact on results. These are some important features that could be used to predict the students' performance.

CGPA: CGPA indicates previous semester results in average.

Attendance Marks (ATM): Student should have at least 50 percent attendance to sit for the final examination.

Attributes	Possible Values
CGPA	≥3.75: excellent; ≥3.50 &&< 3.75:v_good; ≥3.00 &&<3.50:good; ≥2.50 &&<3.00: medium; ≥2.00 &&<2.50 pass; < 2.00: low
Attendance (ATM)	≥90%: excellent; ≥80% &&< 90:v_good; ≥70% &&<80:good; ≥50% &&<70:low
Class Evaluation (CEM)	≥80%: excellent; ≥70% &&<80:v_good; ≥60% &&<70:good; ≥50% &&<60:medium; < 50: low
Assignment (ASM)	≥80%: excellent; ≥70% &&<80:v_good; ≥60% &&<70:good; ≥50% &&<60:medium; < 50: low
Midterm Exam (MM)	≥80%: excellent; ≥70% &&<80%:v_good; ≥60% &&<70%:good; ≥50% &&<60%:medium; ≥40% &&<50%:pass; < 40%: low
Final Exam (FM)	≥80%: excellent; ≥70% &&<80%:v_good; ≥60% &&<70%:good; ≥50% &&<60%:medium; ≥40% &&<50%:pass; < 40%: fail

Table 1: Attributes and their possible values for mining process

Assignment (ASM): There should be at least one assignment in each course.

Class Evaluation (CEM): Class evaluation is conducted by the course teacher based on the performance in class test and quiz test. In each course, there will be at least two class tests, two quiz tests.

Midterm Marks (MM): A mid-term examination is held after 6 or 7 weeks of the semester.

Final Marks (FM): A final examination is held at the end of the semester. Final mark (FM) is evaluated by combining ATM, CEM, ASM, MM and the final examination marks.

After these data are imported from the data warehouse, an analysis is carried out inside the system to predict a student's grade in a particular course.

B. Data Set: The following data set was used for classification.

Sl no	CGPA	ATM	CEM	ASM	MM	FG
1	low	low	low	low	low	fail
2	good	v_good	medium	vgood	medium	good
3	v_good	excellent	v_good	excellent	v_good	excellent
4	medium	excellent	medium	vgood	pass	pass
5	excellent	excellent	excellent	excellent	v_good	excellent
6	pass	good	low	good	pass	medium
7	good	v_good	v_good	good	good	v_good
8	medium	v_good	medium	medium	pass	medium
9	medium	good	low	medium	pass	pass
10	low	v_good	low	low	low	fail
11	excellent	excellent	excellent	excellent	v_good	excellent
12	good	excellent	medium	good	medium	good
13	medium	v_good	medium	medium	medium	good
14	medium	v_good	medium	good	medium	medium
15	low	low	good	good	good	good
16	pass	good	low	medium	low	fail
17	good	good	low	excellent	medium	good
18	excellent	excellent	excellent	v_good	v_good	excellent
19	excellent	excellent	excellent	excellent	excellent	excellent
20	good	excellent	good	good	excellent	good
21	good	good	v_good	v_good	excellent	v_good
22	v_good	good	v_good	good	excellent	v_good
23	good	v_good	good	good	medium	good
24	good	good	v_good	v_good	good	v_good
25	v_good	v_good	good	good	good	good
26	v_good	v_good	v_good	good	v_good	v_good
27	v_good	v_good	v_good	v_good	good	v_good
28	pass	good	medium	medium	pass	pass
29	medium	good	medium	good	low	medium
30	good	good	good	v_good	good	good

Sl no	CGPA	ATM	CEM	ASM	MM	FG
31	pass	low	low	low	low	fail
32	low	good	low	low	pass	pass
33	pass	good	good	good	pass	medium
34	medium	good	low	low	pass	pass
35	excellent	v_good	excellent	v_good	v_good	excellent
36	v_good	excellent	excellent	v_good	excellent	excellent
37	good	excellent	excellent	good	excellent	excellent
38	good	v_good	v_good	excellent	excellent	excellent
39	v_good	v_good	excellent	excellent	v_good	excellent
40	excellent	good	good	v_good	good	v_good
41	excellent	v_good	good	v_good	good	v_good
42	excellent	good	good	good	good	good
43	good	low	low	medium	low	fail
44	good	v_good	v_good	medium	v_good	v_good
45	good	good	v_good	v_good	v_good	v_good
46	v_good	v_good	good	good	good	good
47	v_good	good	medium	v_good	pass	pass
48	good	v_good	medium	medium	good	medium
49	excellent	low	low	medium	pass	medium
50	excellent	low	low	medium	low	good
51	low	excellent	v_good	excellent	excellent	excellent
52	low	v_good	excellent	v_good	v_good	v_good
53	good	v_good	excellent	excellent	excellent	excellent
54	pass	good	good	good	pass	medium
55	low	good	medium	good	pass	medium
56	pass	v_good	low	low	pass	pass
57	excellent	low	low	medium	low	good
58	v_good	good	v_good	good	excellent	v_good
59	low	low	medium	medium	low	fail
60	medium	v_good	medium	v_good	pass	pass
61	low	good	medium	medium	pass	pass
62	excellent	v_good	excellent	v_good	v_good	excellent
63	low	v_good	low	low	low	fail
64	low	v_good	low	good	low	fail
65	pass	v_good	medium	good	v_good	good
66	medium	good	low	good	pass	medium
67	low	v_good	low	medium	low	fail
68	medium	excellent	excellent	good	excellent	excellent
69	excellent	v_good	good	good	medium	good
70	good	v_good	excellent	good	excellent	excellent

Table 2: Dataset used for classification

4. Results and Discussion

WEKA explorer is a machine learning software that is designed as a tool of analyzing data. It is an extremely useful software for the educational system, research and applications [Bouckaert et al., 2008]. WEKA is an open-source machine learning data mining software, developed in Java by the Waikato University from New Zeeland [Robu and Stoicu-Tivadar, 2010]. It provides a flexibility to use due to its Graphical User Interface. It supports several data mining functionalities specifically pre-processing, classification, clustering, attribute selection etc. together with visualization tools. WEKA permits to easily build a classifier based on training data [Robu and Hora, 2012]. These techniques are enumerated on the retention that the data or information is attainable as a file or relation.

Figure 3: WEKA explorer interface

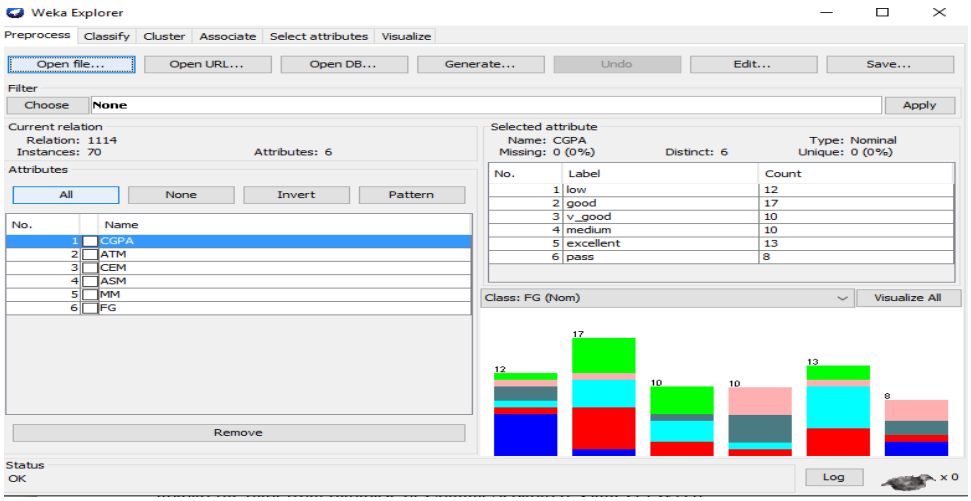

Figure 4: Preprocessing operation performed using WEKA

At first student.csv file is created from above data shown in Table 2. Then it was uploaded into the WEKA explorer for analysis. Pre-processing

panel provides facilities for uploading the data from database or Comma Separated Values (.csv) etc.

Classify panel provides facilities to apply classification algorithms. Several decision trees classification algorithms are in the WEKA. Among them we choose BF tree, Id3, Random Forest, Random Tree and SimpleCart as classification algorithm. There are also several test options in the WEKA. Here, cross validation with 12 Folds and percentage of splits with 66% is selected as test options for evaluation.

Figure 5 and figure 6 display the list of detailed accuracies of BF tree classifier for 12 folds Cross Validation and Percentage of Split. Also a lot of data (Kappa statistic, Mean absolute error, Root mean squared error, Relative absolute error, etc.) displayed implicitly in the Classifier Output section.

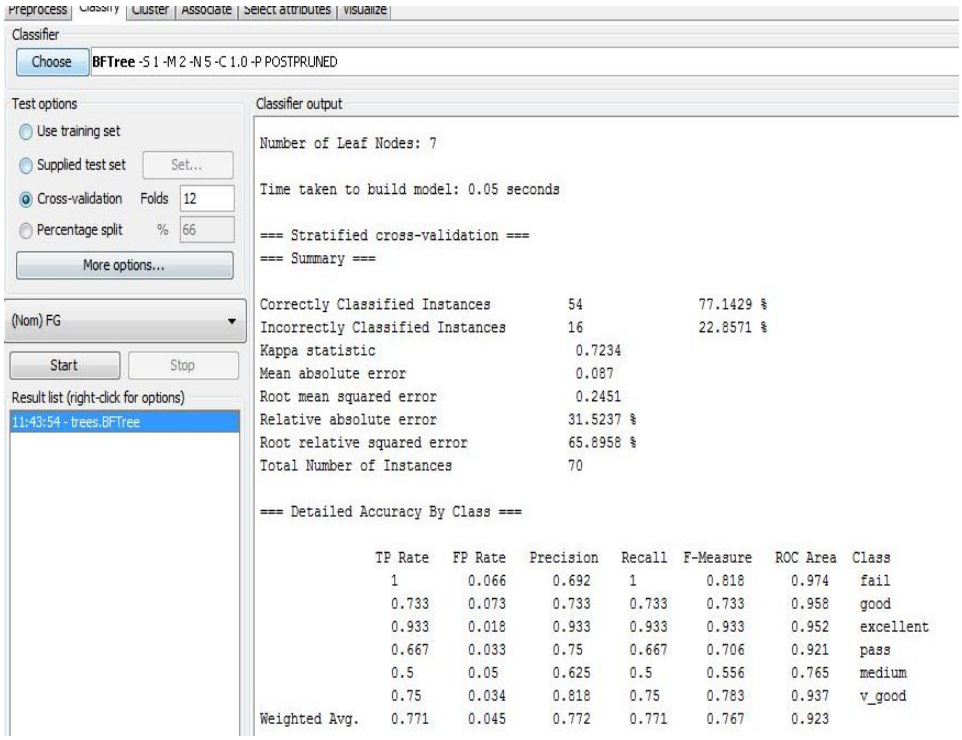

Figure 5: Detailed accuracy of BF tree classifier for the test option 12 folds Cross Validation

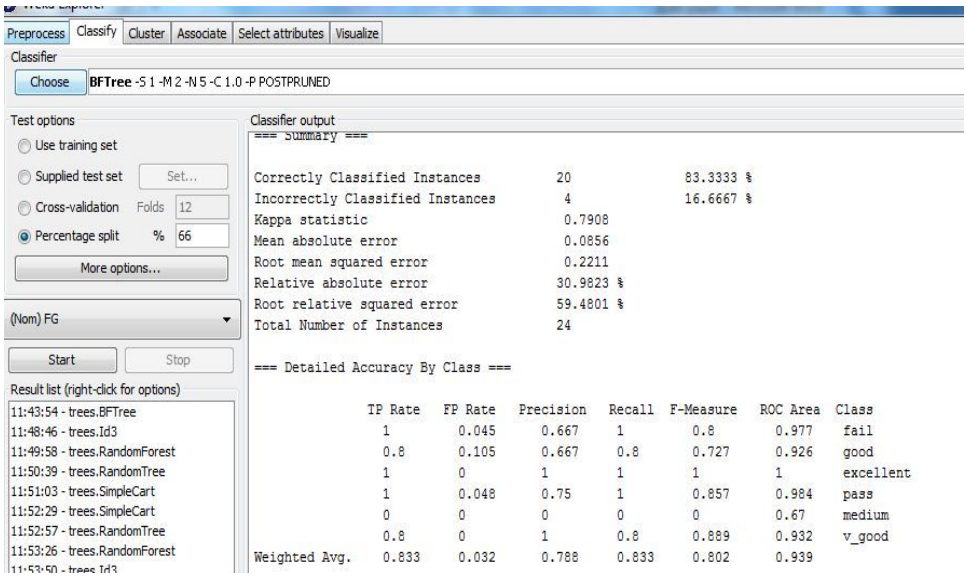

Figure 6: Detailed accuracy of BF tree classifier for the test option 66% Percentage split

Table 3 and Table 4 show the accuracy and mean absolute error of the BF tree, Id3, Random Forest, Random tree and Simple Cart classifier using the test options 12 folds cross validation and 66% percentage of split.

Model	Accuracy	Mean Absolute Error
BF tree	77.1429 %	0.087
Id3	70 %	0.0699
Random Forest	81.4286 %	0.1108
Random Tree	77.1429 %	0.0769
SimpleCart	75.743 %	0.1035

Table 3: Classifier accuracy and mean absolute for the test option 12 folds Cross Validation.

Model	Accuracy	Mean Absolute Error
BF tree	83.33%	0.0856
Id3	58.33%	0.0417
Random Forest	75 %	0.1309
Random Tree	66.667 %	0.1102
SimpleCart	83.33 %	0.0856

Table 4: Classifier accuracy and mean absolute for the test option 66% Percentage of Split.

Table 3 shows that Random Forest technique has the highest accuracy of 81.4286 % compared to other methods for cross validation (12 folds). And Table 4 shows that BF tree and Simple Cart has the highest accuracy of 83.33% compared to other methods for percentage of splits (66%).

Table 5 displays the confusion matrix of BF tree, ID3, Random Forest, Random Tree and Simple Cart classifier generated from WEKA.

Model	Test option: Cross Validation (12 Folds) test option	Test option: Percentage of Split (66%)
BF tree	a b c d e f <-- classified as 9 0 0 0 0 0 | a = fail 3 11 0 0 0 1 | b = good 0 0 14 0 0 1 | c = excellent 0 0 0 6 3 0 | d = pass 1 2 0 2 5 0 | e = medium 0 2 1 0 0 9 | f = v_good	a b c d e f <-- classified as 2 0 0 0 0 0 | a = fail 1 4 0 0 0 0 | b = good 0 0 7 0 0 0 | c = excellent 0 0 0 3 0 0 | d = pass 0 1 0 1 0 0 | e = medium 0 1 0 0 0 4 | f = v_good
Id3	a b c d e f <-- classified as 8 0 0 0 0 0 | a = fail 0 8 1 0 1 2 | b = good 0 1 12 0 0 2 | c = excellent 0 0 0 8 1 0 | d = pass 0 1 0 1 5 0 | e = medium 0 2 1 0 0 8 | f = v_good	a b c d e f <-- classified as 2 0 0 0 0 0 | a = fail 0 3 0 0 0 0 | b = good 0 0 5 0 0 0 | c = excellent 0 0 0 1 1 0 | d = pass 0 0 0 0 0 0 | e = medium 0 0 1 0 0 3 | f = v_good
Random Forest	a b c d e f <-- classified as 8 0 0 0 1 0 | a = fail 1 11 1 0 1 1 | b = good 0 0 15 0 0 0 | c = excellent 0 0 0 9 0 0 | d = pass 1 2 0 3 4 0 | e = medium 0 1 1 0 0 10 | f = v_good	a b c d e f <-- classified as 1 1 0 0 0 0 | a = fail 0 4 0 0 1 0 | b = good 0 0 7 0 0 0 | c = excellent 0 0 0 1 2 0 | d = pass 0 1 0 1 0 0 | e = medium 0 0 0 0 0 5 | f = v_good
Random Tree	a b c d e f <-- classified as 8 1 0 0 0 0 | a = fail 0 13 0 0 2 0 | b = good 0 0 15 0 0 0 | c = excellent 0 1 0 6 2 0 | d = pass 4 1 0 2 2 1 | e = medium 0 1 1 0 0 10 | f = v_good	a b c d e f <-- classified as 1 0 0 0 1 0 | a = fail 0 4 0 0 0 1 | b = good 0 0 5 0 0 2 | c = excellent 0 0 0 2 1 0 | d = pass 0 1 0 1 0 0 | e = medium 0 0 1 0 0 4 | f = v_good
SimpleCart	a b c d e f <-- classified as 9 0 0 0 0 0 | a = fail 3 12 0 0 0 0 | b = good 0 0 13 0 0 2 | c = excellent 0 0 0 6 3 0 | d = pass 1 2 0 2 5 0 | e = medium 0 2 2 0 0 8 | f = v_good	a b c d e f <-- classified as 2 0 0 0 0 0 | a = fail 1 4 0 0 0 0 | b = good 0 0 7 0 0 0 | c = excellent 0 0 0 3 0 0 | d = pass 0 1 0 1 0 0 | e = medium 0 1 0 0 0 4 | f = v_good

Table 5: Confusion Matrix

Table 6 shows the time taken (time complexity in seconds) to build the model of various classifier for training data.

Classifier	Time taken to build model	
	Cross Validation	Percentage of Split
BF tree	0.26 seconds	0.04 seconds
Id3	0 seconds	0.01 seconds
Random Forest	0.04 seconds	0 seconds
Random Tree	0 seconds	0 seconds
SimpleCart	0.06 seconds	0.02 seconds

Table 6: Execution Time of the Cclassifier

Figure 7 and Figure 8 show the comparison of classifiers on data sets in Table 2 is represented in the form of a graph.

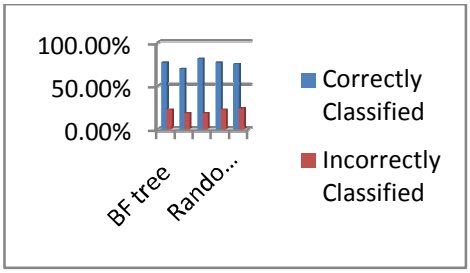

Figure 7: Comparison of the classifier for the test option 12 Folds Cross Validation

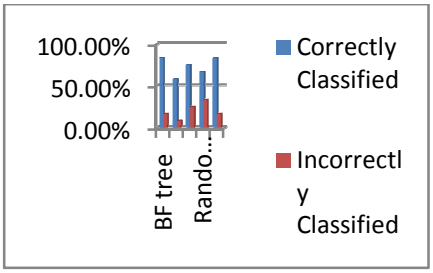

Figure 8: Comparison of the classifier for test option 66% Percentage of Split

The following Table 7 shows the knowledge generated and extracted from the dataset using BF tree classifier and represented in the form of decision tree. From the model below, we can easily generate classification rules (e.g. if-else) which will help us to predict final result of a student. If we get prediction of failure situation for student then we can search for previous data of the student in data warehouse and get the failure factors such as how student performed in

```
CEM=(medium)|(low)|(good)
|  MM=(pass)
|  |  ASM=(good): medium
|  |  ASM!=(good): pass
|  MM!=(pass)
|  |  MM=(low): fail
|  |  MM!=(low): good
CEM!=(medium)|(low)|(good)
|          CEM=(excellent)|(low)|(medium)|(good):
excellent
|  CEM!=(excellent)|(low)|(medium)|(good)
|  |  ASM=(excellent): excellent
|  |  ASM!=(excellent): v_good
```

Table 7: Generated model of BF tree classifier using WEKA

related subjects, how many classes he attended in a particular subject that he passed or failed etc. It will ultimately help us in a global scale. We will be able to predict probable drop out students or students with possible bad performance and act according to it.

5. Conclusion

The goal of identifying the student's final performance using previous academic records based on decision tree classification technique is achieved. In this study, attributes affecting the academic success are primarily selected from the properties in the student data warehouse. Decision tree classification techniques are conducted to find out the best model and this model can be used to predict the final result of a student by using data mining tools WEKA. Experimental results show that Random Forest is the best classifier in the case of cross validation (accuracy 81.4286 %) and BF tree and Simple Cart is the best classifier in the case of percentage of splits (accuracy 83.33%) for this dataset which is very much satisfactory. Basically system predicts based on previous records so the predictions may change when data (class test, quiz, midterm etc.) of the students change. This model helps in identifying the dropout, students who need special attention. This allows the teachers to give appropriate counseling to the students. By this method institutes can find weak points of students and directly target that point to improve student skill which can help to create better workforce for country's development. Also we can warn them about their performance and give suggestions to support them, inform the guardian of the respective students to carefully inspect of the study period, suggest them to group study, and personal guideline according to student learning nature. It reduces the failure rate. It minimizes to retake a course taken by the students and also improve the university's reputation. Future opportunities to continue this research are enormous .Using these data warehouses we should be able to find individual students who are performing impressively in a particular subject or sector.

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Comparison of Downlink Throughput Performances between Diversity and Beam Forming

Mst. Rubina Aktar

Abstract

Long term evolution (LTE) promises to provide high data rates by integrating various multiple input and multiple output (MIMO) transmission modes. Spatial multiplexing is introduced to transmit data over multiple spatial layers, increasing the instantaneous throughput of the user equipment (UE). Diversity is introduced that uses special encoder and decoder to immune the transmitted data. Moreover it sends the same data over the multiple antennas. This increases the SINR at the receiving end. A high SINR is required to achieve better performances, specially the cell edges, where a fall in signal to interference plus noise ratio (SINR) may lead to a null throughput, causing an active call being dropped during cell transitions by the UEs. This is undesirable in terms of quality network performances. Moreover, an increase in UE velocity produces a Doppler effect which will cause an additional loss in signal power due to an increased fading. Spatial multiplexing suffers at high velocity. The MIMO techniques that can withstand the Dopplereffect and provide a better throughput at large distances are transmit diversity and beamforming.In this work, average UE, cell edge and peak throughputs has been analyzed and compared between diversity and beam forming techniques. An extensive Monte Carlo simulation has also been carried out to asses which MIMO scheme is suitable to improve SINR at the receiver end for better UE and network performances.

Keywords: MIMO, transmit diversity, beam forming, average user threshold, cell edge threshold, peak threshold, SNIR, BER.

1. Introduction

LTE, a 4G technology, is designed to improve latency, data rate and efficient spectrum utilization. Orthogonal Frequency Division Multiple Access (OFDMA) scheme is implemented to improve throughput and spectral efficiency in the downlink transmission [1]. Macro cell network suffers from significant shadow and multipath fading in urban environments. This degrades the received signal to interference plus noise ratio (SINR) by the user equipment (UE). Moreover with ever-escalating

user density, maximum attainable data rate by a UE within a network also decreases due to the exhaustion of resource blocks (RBs) made available by the allocated bandwidth. One of the lucrative features of LTE is its easy integration of several multiple-input and multiple-output (MIMO) modes to acquire high-data rate and better spectral efficiency. For a bandwidth of 20MHz a maximum data rate of 86.4Mbps and 326.4Mbps can be achieved in the uplink and downlink respectively [2]. Spatial multiplexing increases the number of transmitted data streams via multiple antennas and the channel capacity increases linearly with the number of layers transmitted. On the other hand, the diversity technique uses space time block code (STBC) to transmit the multiple version of the same signal along multiple antennas. This improves the SINR of the signal at the receiver end. Recently LTE standard introduced beam forming that employs a shift in phase on an antenna to focus its signal so that it arrives at the UE at the same time as the other antennas thus achieving a SINR gain [3].

Friedlander et.al compared the diversity and beam forming techniques in terms of outage probability and transmits power [4].Diversity vs. beam forming is compared in terms of bit error rate (BER) for indoor micro and Pico cells and urban macro cells [5].

In this paper, the two MIMO techniques that increase the SINR gain of the UEs (transmit diversity and beam forming) are analyzed and compared to conclude which technique provides a better average user equipment, cell edge and peak cell throughputs for outdoor urban environment in a macro cellular network.

The remainder of the paper is summarized as follows. In section II, the system model is described which presents the network layout, brief description on transmit diversity and transmit beam forming and the key performance indicators. Simulation parameters are presented in section III. Results and discussion are given in section IV and finally section V presents the conclusion.

2. System Model

A. Network Model

A downlink multi-cell cellular network deployed using regular hexagonal cell layout is shown in Figure 1. Before starting the analysis, some parameters such as base station, antenna height, transmitted power,

channel bandwidth, path-loss model, fading, cell radius, carrier frequency and transmitting power are assumed.

To compare the performance of the diversity and beam forming techniques network architecture of 7 base stations (BSs) is considered. Figure 1, depicts the designed network used for the simulation**.** Tri-sector antennas are considered for each BS and the cell radius of 1000m is used.

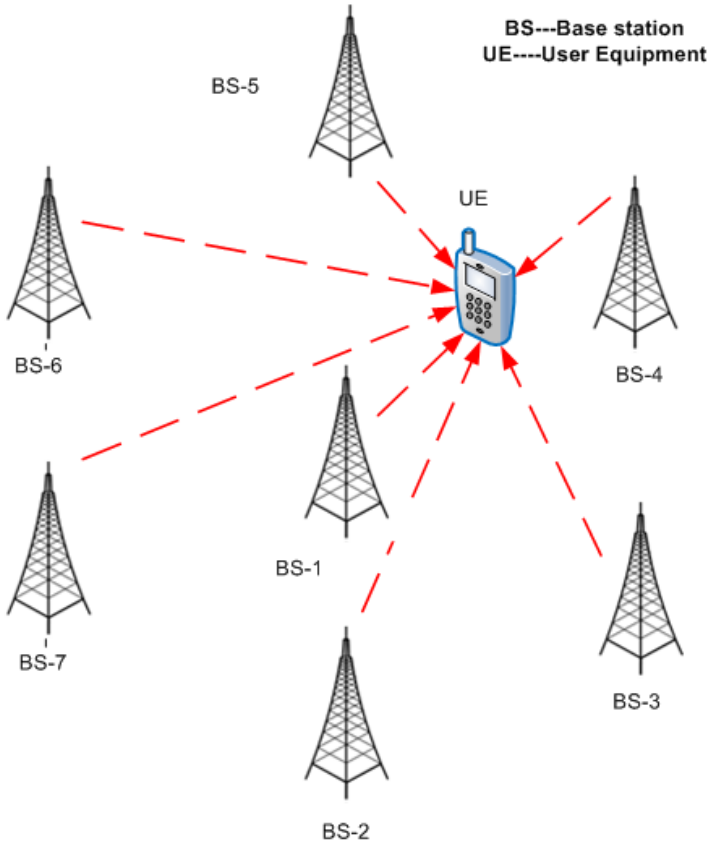

Figure 1.User and base station distribution network layout.

B. Transmit Diversity

Diversity scheme employs the transmission and reception of the multiple versions of the same signal at different antennas. It helps to overcome the effects of fading. When using diversity transmission and reception, the amount of received signal improvement depends on the independence of the fading characteristics of the signal as well as circuit outages and failures. Considering antenna diversity, in many systems additional

antennas may be expensive or impractical at the remote or even at the base station. In these cases, transmit diversity can be used to provide diversity benefit at a receiver with multiple transmit antennas only. With transmit diversity; multiple antennas transmit delayed versions of a signal, creating frequency-selective fading, which is equalized at the receiver to provide diversity gain. There are two types of diversity schemes: transmit and receive diversity. In transmit diversity, multiple transmit antennas is employed at the BS transmission side with fewer receiver side antennas, whereas in receive diversity; there are more number of receiver side antennas than the transmission side. But both the schemes transmit and receive the same data at a given transmission interval. In our simulations, a 2x1 transmit diversity scheme is considered which is depicted in Figure 2(a).

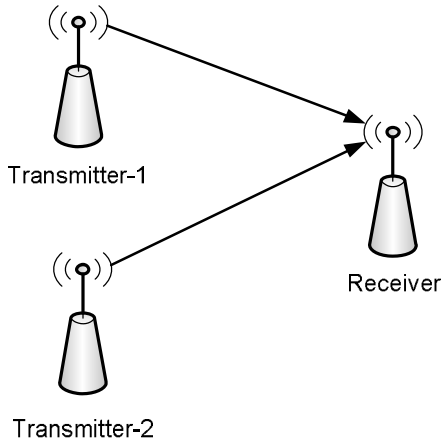

Figure 2(a). Transmit diversity scheme.

For the 2x1 diversity scheme Alamouti's space time block code encoder is used [6] and for Orthogonal Frequency Division Multiple Access (OFDMA) downlink transmission that I have used, the diversity technique considered is depicted by the following block diagram.

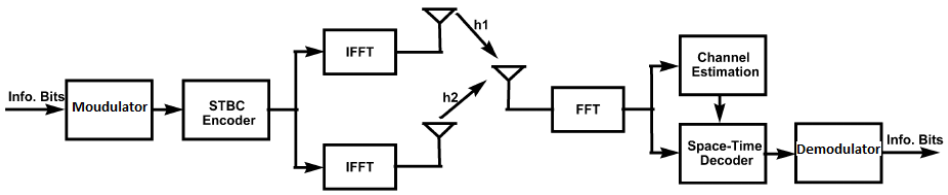

Figure 2(b). Alamouti scheme 2x1 for OFDMA downlinks transmission.

C. Transmit Beam Forming

In transmit beam forming; identical signals with a phase shift from one another are transmitted from independent antennas at a particular direction [7]. The signals then constructively interfere at a particular point in space increasing the received signal, hence resulting in a SINR gain. To explain the beam forming process in very simple terms, beam forming works by shaping the beam towards the receiver. Multiple antennas all transmit the same signal, but each is specially distorted in phase. For beam forming simulation a 2x1 scheme is selected which is illustrated by Figure 2(c).

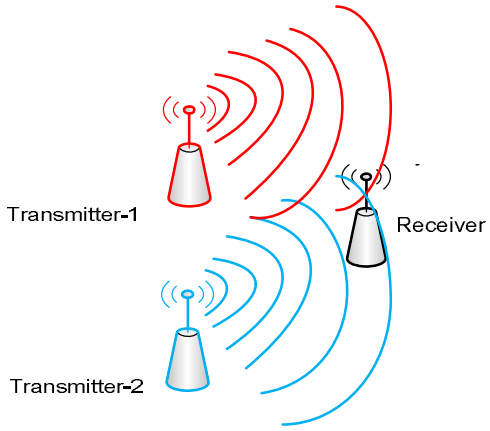

Figure 2(c). Transmit Beam Forming scheme.

D. Key Performances

Average UE throughput: Users in a cellular network are located randomly relative to the base station. UEs receive the highest SINR when closer to the BS. Received signal quality decreases as the UE moves far away from the BS. Thus UEs under a single base station have a wide range of SINR. Data rate depends on the SINR received by the UE, therefore a wide SINR range received by the UEs results in a high UE throughput diversity. Therefore for a better understanding on the impact of multiple inputs and multiple output technique on the UE performance average UE throughput is considered which is defined as the 50^{th} percentile of the throughput empirical cumulative distribution function (ECDF).

Cell edge throughput: Throughput at the edges of a cell is an important parameter to be considered. This is because that if a minimum data rate is not achieved at the cell boundaries then there will be call drops during cell

transitions minimizing the possibility of ell handovers of the UEs. This is undesirable as in real scenarios UEs are in continuous motion. Cell edge throughput is defined as the 95th percentile of the throughput empirical cumulative distribution function.

Peak cell throughput: Maximum data rate is essential to determine whether a particular UE operation can be accommodated by the cellular network. For example, live video streaming requires a higher data rate than textual data transmissions. Peak cell throughput is defined as the 95th percentile of the throughput empirical cumulative distribution function.

3. Simulation

To determine the SINR and throughput ECDF's Monte Carlo simulation of 1000 iterations is performed. At first, UE is located randomly within the designed network. Then the received SINR from each of the BSs is calculated. SINR form the BS which is nearer to the UE is selected as the received SINR by the UE. Macroscopic path loss model for urban environment considered for the microcell BSs are given below:

$$PL\_dB = 20\log_{10} d_O + 20\log_{10} f_c + 92.45 + 10\alpha l \log_{10} \frac{d}{1000 d_O} (1)$$

Where *'d* is the distance of user from any base station in kilometers, f_c is the carrier frequency in

MHz. From the received SINR the UE throughput is calculated using the following formula:

$$C = BW \log_2(1 + SINR) (2)$$

This gives the maximum throughput achievable under a certain SINR. But in practice, the throughput is limited by the BER which varies with the multiple input and multiple output technique being used. Therefore using mat lab BER is calculated both for transmit diversity and transit beam forming which are illustrated in Figure 3. To calculate the BER, SINR and modulation order is required. SINR computation is mentioned earlier and the modulation index is obtained from Table 1 by comparing with the received SINR.

Table 1: Modulation Scheme for LTE

CQI Index	Modulation Order	Code Rate×1024	Rate r[8] (bits/symbol)	β_m r[7]	SINR threshold Γw/ 10% BLER(dB)
0	Out of range				
1	QPSK	78	0.1523	1.00	-9.478
2	QPSK	120	0.2344	1.40	-6.658
3	QPSK	193	0.3770	1.40	-4.098
4	QPSK	308	0.6010	1.48	-1.798
5	QPSK	449	0.8770	1.50	0.399
6	QPSK	602	1.1758	1.62	2.424
7	16QAM	378	1.4766	3.10	4.489
8	16QAM	490	1.9141	4.32	6.367
9	16QAM	616	2.4063	5.37	8.456
10	16QAM	466	2.7305	7.71	10.266
11	64QAM	567	3.3223	15.5	12.218
12	64QAM	666	3.9023	19.6	14.122
13	64QAM	772	4.5234	24.7	15.849
14	64QAM	873	5.1152	27.6	17.786
15	64QAM	948	5.5547	28	19.809

Once the BER for a particular multiple input and multiple output technique is computed, the actual throughput is calculated by:

$$(1 - BER) * C \quad (3)$$

Higher the BER for a particular modulation under a specific scheme will reduce the achievable data rate. Additional simulation parameters implemented are tabulated in Table 2.

Table 2: Simulation Parameters

No. of transmitter	2
No. of receiver	1
Transmitting mode	Transmit Diversity, Transmit Beam forming
Fading	μ=0dB, σ=8dB
Transmitting power	43dBm
Cell radius	1000m
Path loss	WINNER II
Bandwidth	5MHz
Carrier frequency	2 GHz

Once the Monte Carlo simulation is completed the obtained SINRs and throughputs are then used to plot the ECDFs.

4. Result and Discussion

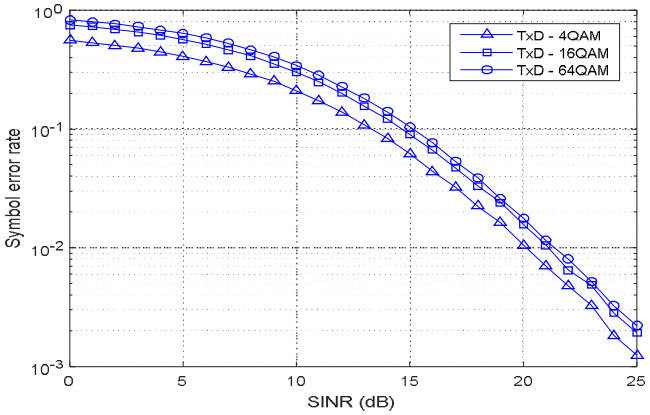

Figure 3(a). Symbol error rate vs SINR for transmit diversity under different modulation schemes.

It is evident from Figure 3(a), that the transmit diversity is robust under a wide range of modulation orders and the BER for a certain SINR presents similar BER for different modulations under the diversity scheme. Since 4-QAM carries the minimum data it experiences the minimum error. With the increase of modulation order the BER also increases but slightly for the transmit diversity scheme.

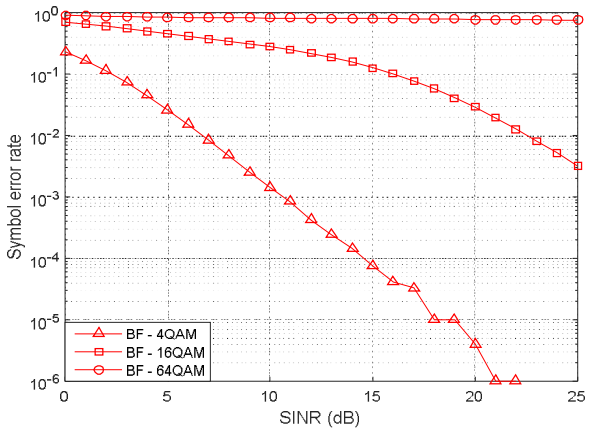

Figure 3(b). Symbol error rate/BER vs. SINR for transmit beam formingscheme

In contrast, the bit error rate of beam forming as illustrated by Figure 3(b), depends significantly on the order of modulation. Erroneous transmission under 4-QAM and 16-QAM decreases with the increase in SINR. On the other hand, 64-QAM experiences significant loss in the SINR range considered and decreases for very high SINRs which can only be available at the vicinity of the BS.

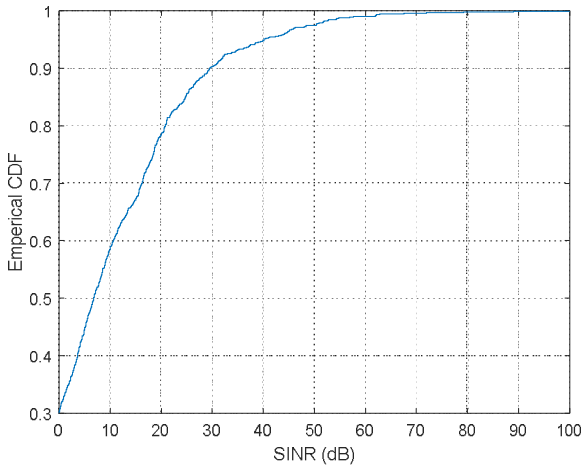

Figure 4(a). Empirical CDF vs. SINR of the cellular network in consideration.

Empirical cumulative distribution function (ECDF) increases with the increase in SINR, when I move towards the BS, as is expected from a cellular network. The Empirical cumulative distribution function trend, shown by Figure 4(a) is applicable to both the multiple input and the multiple output schemes considered as they receive the same SINRs which depend only on the position of the UE relative to the base station.

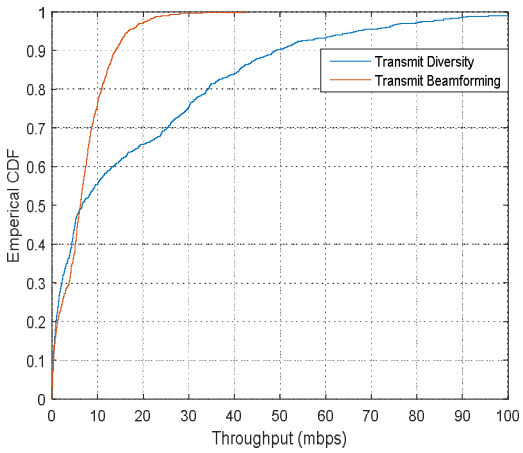

Figure 4(b). ECDF Throughput Vs. Throughput of the diversity (2x1) and beam forming (2x1) schemes.

Empirical cumulative distribution function (ECDF) of beam forming reaches 1 at a lower throughput compared to diversity. This suggests that using diversity technique UEs have a good possibility of achieving a higher data rate than beam forming. Empirical cumulative distribution function of Diversity approaches 1 at around 100 mbps which is approximately x4 times higher than that is achieved by beam forming.

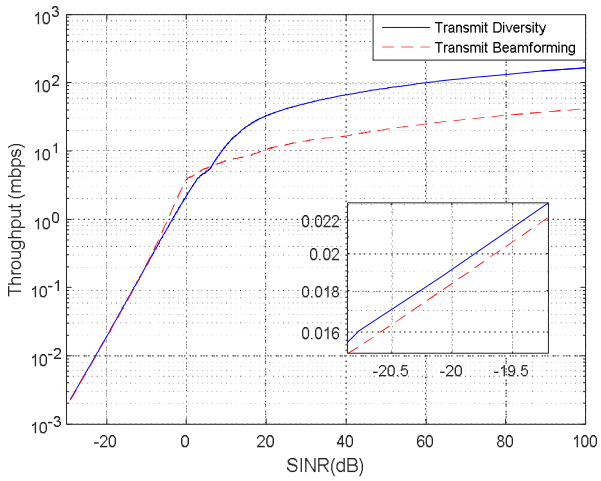

Figure 5. Throughput vs. SINR for diversity and beam forming.

Figure 5 illustrates that the throughput under both schemes increases with a similar pattern with the increase of SINR. For low SINR range both the transmit diversity and beam forming delivers similar performances because both the techniques experience a low bit error rate at the lowest modulation order of 4-QAM. But at high SINRs, which is subjected the interior of the cell, higher throughput is delivered by the diversity scheme than beam forming. This can be understood from the bit error rate plots, where for high data rate at high SINR requires the highest modulation rate of 64-QAM. Since, beam forming at 64-QAM is subjected to a higher BER than diversity it experiences a significant performance degradation.

Table 3: Average UE, cell edge and peak data rates for diversity and beam forming

Scheme	Average UE throughput (mbps)	Cell edge throughput (mbps)	Peak throughput (mbps)
Transmit diversity	7.23	0.36	66.8
Beam forming	7.15	0.358	16.7

5. Conclusion

As depicted by Table 3, both the diversity and beam forming techniques on average deliver a similar data rate to the UEs in a cellular network. A similar cell edge performance is also experienced under either MIMO scheme. As they increase the user SINR, a minimum performance at the cell edge ensures a ubiquitous network coverage thus reducing the possibility of the active calls being dropped. On the contrary, a significant performance enhancement of around 4 time is obtained under the diversity scheme over beam forming. This suggests that UEs can benefit from high data rate applications such as live video streaming, online gaming, etc. under transmit diversity scheme.

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Effect of Silicon Softener Finishing on Air Permeability and Drape of Different Knitted Fabrics

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Aminul Islam Mishuk

Abstract

Comfort and attractiveness are the most significant prerequisites of knitted fabric manufacturing. To attain these desired properties, different types of finishing are applied on knitted fabric. Among these silicon washing is one of the favorite techniques to increase the soft handle of fabric. Silicone softeners make fabric not only softer, brighter and slippery but also more elastic in order to produce desirable handle. In this work the effect of silicone softeners on air permeability and drape of fabric is discussed by changing the amount of softener percentage. It was a great effort to find out the optimum level of silicon softener which will be feasible for air permeability and drape of weft knitted fabric for different structure made from the same profiled cotton yarn. From the results it is clear that if the amount of silicon softener percentage increases then the air permeability of knitted fabric decreases and drape co-efficient increases which influence the various properties of garments. It was found that the application of softeners has a significant effect on air permeability and drape with respect to untreated fabrics.

Key words: Softener, Knitted fabric, Air permeability and Drape etc.

1. Introduction:

The clothing and textiles are an integral part of our daily lives. These are produced by various methods like as weaving, knitting, non-woven etc. Among these knitting is a process of fabric formation that involves the interloping of yarn in a series of connected loops by means of needles, sinker and cam etc. Knitted fabrics have been extensively used in readymade garments for higher level of hand feeling, elasticity, extensibility, mechanical and comfort properties than woven fabrics. In recent years, we witnessed growing interest in knitted fabrics due to their simple production techniques, low cost, high levels of clothing comfort and wide product range. As it is known that yarn used for knit fabric needs no preparations like warping and sizing, yarn can directly feed on machine after receiving from spinning mills. Different properties of knit fabrics can

be modified by introducing miss and tuck loops on its structures where the basic knit structures contain knit loops only. They also possess high extensibility under low load, allowing a comfortable fit on any part pulled. Furthermore they are also light weight and flexible (Mikucioniene 66). These characteristics make knitted fabrics the commonly preferred choice for sportswear, casual wear and underwear. Efforts have been made to make knitted fabrics more comfortable by incorporating different fibres, altering yarn parameters like twist, bulk, count and finishing treatments, knitting factors like stitch length, course, wale and fabric aerial mass, and by adopting new or different finishes (Parmar 41). Textile materials are usually exposed to thermal, physical and mechanical effects during treatment processes. Fabric comfort characteristics depend on various fabric properties such as smoothness of the fabric surface, knitting structure, air permeability, thermal resistance, heat transmittance, water-vapour permeability, hydrophilicity and liquid vapour permeability (Das 116). Air permeability is an important property of clothing comfort and is defined as the rate of volume of air passed perpendicularly through a unit area of fabric at some pressure gradient over a unit time (Bedek 792). Air permeability maintains the thermal balance of the wearer by permitting the air to move through the clothing particularly after exercise or any other strenuous activity (Kar 537). Air permeability is often used in evaluating and comparing the "breathability" of various fabrics for end uses such as raincoats, tents, and uniform shirting's. The air permeability of a fabric can influence its comfort behaviors in several ways such as a material that is permeable to air is, in general, likely to be permeable to water in either the vapour or the liquid phase. Thus, the moisture-vapour permeability and the liquid moisture transmit and make that garments comfortable. Fabric drape is the ability of a fabric (circular specimen of known size) to deform when suspended under its own weight in specified conditions (BSI 2008). It is one of the important factors influencing the aesthetics and functionality of fabrics as well as the created garment. In general, drape ability is described as a phenomenon of fabric-fold formation, which arises when a fabric hangs down without the influence of external forces. Basically, fabric drape is not an independent fabric property. It depends on the fabric's parameters such as structure, yarn type, fibre content, as well as its finishing treatments (Žunič 39). It is needed when we are modeling the cloth in virtual environment. Fabric drape along with lustre, colour, texture, etc. defines fabric and garment appearance. Drape is normally subjectively evaluated by textile and apparel workers in the design and manufacturing industry. Due to the limitations of individuals' assessments,

from the lack of reproducibility to inconsistent agreement between assessors etc, researchers have worked on interpreting drape quantitatively for softener finishing. It plays a major role in aesthetic appeal of fabric particularly when used as skirt, table-cloth, curtain, etc. It is directly related to textile aesthetics, which is important for the development, and selection of textile materials in apparel industries and especially for the design of clothes such as dresses and skirts. Drape ability of textiles is judged subjectively and is dependent on people□s skill and experience, which render difficulties during drape comparisons, especially when judged by different people (Pratihar 1007). We need to take into account that each time a fabric is draped, it hangs in a slightly different configuration. The reasons for this unpredictable shape of fabric drape are the above-mentioned fabrics' parameters, including non-homogenous fabric structure, the shape of the object over which the fabric is draped, as well as the environmental and other conditions. Each fabric drapes or hangs differently. The folding takes a complex three dimensional form with a double curvature. It represents the gracefulness of a fabric's appearance and its comfort touch (Hu 220). A number of parameters affect the drape of a fabric and it is important to identify them. The textile industries have realized the importance of understanding this qualitative phenomenon of the drape for capturing the consumer market. (Chu 539).In different commercial types of softeners, applications are available with different concentrations and proportions of ingredients viz., amphoteric, anionic, cationic, non ionic and reactive silicone softeners. Silicone softeners have little affinity towards textile materials because they are compatible with other finishing agents and can be applied to both natural and man-made fiber fabrics. The application of silicone softener to easy care finished fabric decreased the fabric friction and a further increase in the crease recovery angle was observed. Easy care finishing marginally changed the bending length, which is reduced, to some extent, by the application of silicone softener (Kurlageri 68), giving better inner and surface softness, lightness, elasticity, easy sewing as well as high tear and abrasion resistance to textiles (Özgüney 121). *Commercially used silicone softeners with three different particle sizes (macro, micro) were applied on these fabrics by a continuous method in identical conditions.* The effect of silicone nano emulsion softener against silicone conventional softener on the softness, feel, wrinkle recovery, absorbency, soiling and tensile properties of cotton fabrics. It was stated that softener improves the feel, softness and crease recovery of cotton fabric (Chattopadhyay 68). *The impact of using different softeners on the weight, thickness, pilling*

resistance, wet and dry rubbing fastness, total colour change, drape and air permeability of these fabrics has a great influence. The effects of various knit structures on the dimensional, mechanical and comfort properties of knitted fabrics have been analyzed by many researchers. The structure of a fabric plays a vital role in determining its air permeability and the drape of fabric. Silicon softener is used in finishing of knitted fabric for developing the handle and aesthetic properties to give the wearer a convenient wearing condition by avoiding skin irritation to maintain a particular shape of garments. The study and comparison of air permeability and drape of various fabric structures have their own significance on account of silicon softener finishing.

2. Materials and Methods

The six knitted fabrics were produced in circular knitting machine.
The yarn specification was stated in the following.

Table 1: Yarn used to produce the samples.

Sl. No.	**Fabric type**	**Yarn Count**
1	Single jersey (Plain)	30^S (Ne)
2	Single lacoste	30^S (Ne)
3	Polo PK	30^S (Ne)
4	Terry	Knit-30^S (Ne) Laying-26^S (Ne)
5	Fleece (Three thread)	Knit-30^S (Ne) Tying-26^S (Ne) Laying-22^S (Ne)
6	Interlock	30^S (Ne)

Table 2: Fabric specification.

Sl. No.	Fabric type	WPI	CPI	Stitch length (mm)	GSM
1	Single jersey (Plain)	33	54	2.60	142
2	Single lacoste	25	80	2.60	167
3	Polo PK	26	70	2.60	180
4	Terry	27	K-56 L-56	K-2.80, L-1.25	207
5	Fleece (Three thread)	24	K-33 T-33 L-33	K-4.30 T-3.65 L-1.50	267
6	Interlock	68	36	3.30	230

The fabric samples were collected from "Impress Newtex Composite Textiles Limited" Gorai, Mirzapur, Tangail in grey state.

Then the samples were dyed by the same parameters as follows and finished with silicon softener by changing the amount in Wet Processing laboratory under the department of Textile Engineering, "Bangladesh University of Business and Technology (BUBT)", Mirpur-2, Dhaka-1216.

Table 3: Recipe of dyeing.

Particulars	**Amount**
Reactive Dye	2% o.w.f
Wetting agent	1 g/l
Levelling agent	1 g/l
Sequestering agent	1 g/l
Salt	40 g/l
Soda ash	10 g/l
Material : Liquor	1:10
Time	40 minute
Temperature	60°C
pH	10

Required apparatus for air permeability test: Air permeability tester.

Standard: ISO 139

Main Parts: Rotometer, manometer, vacuum cleaner.

Theory: Air permeability = $\frac{(R1+R2+R\ 3)\times 1000}{3600\times \text{Sample area}}$

Sample size: 4cm× 4 cm

Sample preparation: A 4cm × 4cm sample is cut by the help of scissor and scale.

Test Method: After preparing the sample it should be placed into the sample holder of an air permeability tester. All rotometers switch must be closed at this stage. The vacuum provides air which passes through sample fabric. Then the first rotometer (R1) will be opened. It will show value in liter per hour. Then the second rotometer (R2) will show a value on its meter and finally third rotometer will give the value (R3). These values will be used in the formula to find the air permeability of our sample fabric. Values will be obtained in cc/cm/sec.

Required apparatus and materials for drape test: Drape tester, drape template, light box (using UV light for drape test), scissor, ammonia paper and NH_4OH, permanent marker and scale.

Standard: IS 8357-1977

Theory: Drape co-efficient = $\frac{\text{Mass of shaded area of paper ring}}{\text{Total mass of ammonia paper ring}} \times 100\%$

Sample preparation: The required sample will be prepared by the help of drape template, a pair of scissors and a permanent marker pen. Two area outside and inside of the drape template is drawn after keeping it on the fabric. A pair of scissor is used to cut the sample from inside and outside.

Test procedure: After cutting the circular sample it is placed in disk holder of drape tester. A 12"×12" size ammonia paper is cut by the scissor and its (12"×12"size) weight must be measured. Ammonia paper is placed in developing chamber and the NH_4OH is kept in chemical chamber of the drape tester. The door of drape tester is closed during the test. The test is continued for 10 minutes. A shaded area of fabric will be developed on ammonia paper. This area should be marked and viewed under UV light. This area must be cut and measured by weight measuring balance. Both measured weight will be used in the required formula of drape co-efficient.

These above mentioned tests were carried out in the Textile Testing and Quality Control (TTQC) laboratory under the department of Textile Engineering, Bangladesh University of Business and Technology (BUBT), Mirpur-2, Dhaka-1216.

3. Result and Discussion

The results of the samples are tabulated and can be explained as follows:

Table 4: Air permeability of different knit fabrics after applying different amount of silicon softener.

Sl. No.	Fabric type	Air permeability (cc/cm/sec) after applying Silicon Softener (0.5% o.w.f.)	Air permeability (cc/cm/sec) after applying Silicon Softener (1% o.w.f.)	Air permeability (cc/cm/sec) after applying Silicon Softener (1.5% o.w.f)
1	Single jersey (Plain)	140	129	126
2	Single lacoste	156	150	149
3	Polo PK	153	150	147
4	Terry	150	147	145
5	Fleece (Three thread)	164	163	162
6	Interlock	160	158	154

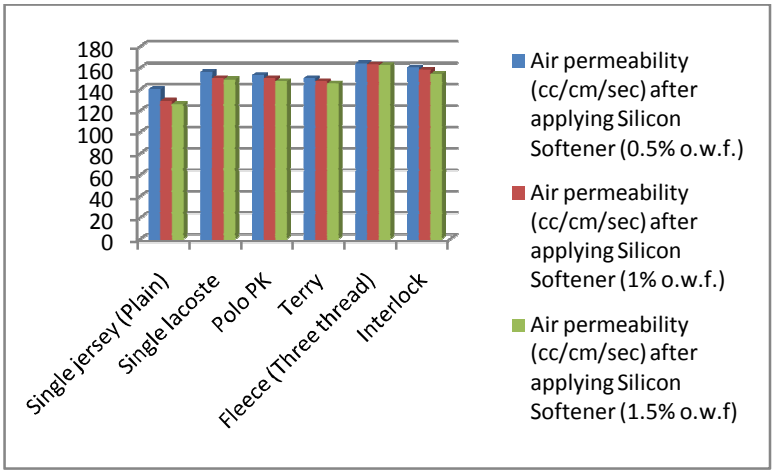

Figure 1: Air permeability of different knit fabrics after applying different amount of silicon softener.

It is obvious from Table 4; that if the amount of softener is increased then the air permeability of knit fabric will be less. As more amount of softener will fill the gap between wales and course of knit fabric, so knit fabric will be less permeable. It will create a problem of comfort ability of garments. Less amount of air can pass through the fabric as a result the wearer will feel uncomfortable. For example we can say from table 4; that sample 1 (Single Jersey) fabric will have lesser air permeability when it has more softener. When 0.5% o.w.f (on the weight of fabric) softener is applied

single jersey fabric will have air permeability of 140cc/cm/sec and gradullay it is seen that 1% o.w.f. silicon will provide air permeability of 129 cc/cm/sec and 1.5% o.w.f. silicone can produce 126 cc/cm/sec, doubling the amount of softener to decrease the air permeability of fabric. The garments made from higher amount silicone will eventually give uncomfortable garments. Among six testing samples, the single jersey fabric is most air permeable and fleece fabric has the least air permeability.

Table 5: Drape coefficient of different knit fabrics after applying different amount of silicon softener.

Sl. No.	Fabric type	Drape co-efficient% after applying Silicon Softener (0.5% o.w.f.)	Drape co-efficient% after applyingSilicon Softener (1% o.w.f.)	Drape co-efficient% after applyingSilicon Softener (1.5% o.w.f)
1	Single jersey (Plain)	22%	24%	25%
2	Single lacoste	25%	26%	28%
3	Polo PK	23%	26%	28%
4	Terry	27%	28%	29%
5	Fleece (Three thread)	29%	29%	32%
6	Interlock	28%	28%	30%

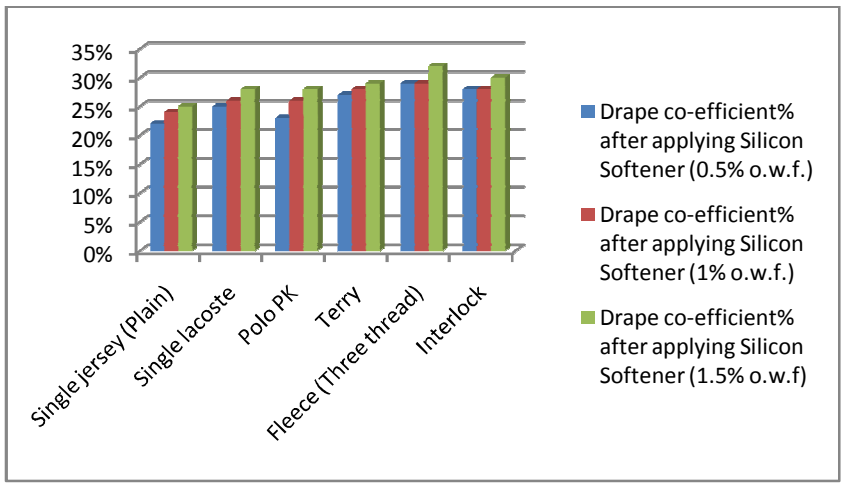

Figure 2: Drape coefficient of different knit fabrics after applying different amount of silicon softener.

Another study from Table 5; ensures that if the amount of softener is increased on knit fabric then the drape co-effcient of fabric will also be increased. This happens mainly for the gaining of weight by the fabric after applying softener. Although the study shows that the use of softener does not remarkably affect drape co-efficient, results found here are quite acceptable. It is obvious from Table 3 that if we apply silicon softener of 0.5% 0.w.f. then the single jersey fabric will have drape co-efficient of 22%. After applying 1% and 1.5% o.w.f. silicone on single jersey fabric it produces drape co-efficient of 24% and 25%. So the drape is increasing by applying more softener. Six samples are tested and finally results show that single jersey fabric has lesser drape than other sample fabrics and fleece fabric has the highest drivability.

4. Conclusion

Knitted fabrics are the preferred structures in athletic wear in which the demand for comfort is a key requirement. Heat and liquid sweat generation during athletic activities must be transported out and dissipated to the atmosphere. The temperature around the world is rising rapidly. During the summer season customers demand more comfortable garments. By using softener garments can be made soft and comfortable. But we have to be careful about the use of the softener, as more softener is not good for air permeability. By using a standard amount of softener it will be possible to make the garments more human friendly. It will create a soft handle on finished garments. On the other hand it is clear that softener increases the weight of the fabric. So drape co-efficient will also increase for this reason. Increasing amount of drape is not better for garments. As more drape develops more unsightly appearance of garments, it is not desirable. Sportswear and people who are working at higher humidity need more air permeable garments. It is suggested from this work that the sample no 1 (Single jersey), 3 (Polo PK) & 4 (Terry) will be better for making more air permeable textile products. If the above mentioned personals use garments made from these fabrics they will certainly feel more comfortable and relaxed. It will enhance their performance in their respective working field also. While the increased use of softener provides more drape on garments, the results show that single jersey, single lacoste and Polo PK have less drape than the other sample fabrics. So they can be used for making different garments. It indicates that Silicon should be used in a limited manner so that the garments have its attractive look. So manufactures should use this idea to make more environment friendly garments for their consumers and at the same time should be more careful during the use of softener.

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Performance Comparisons and Robustness Considerations of Selftuning Regulators

Engr. M. Azharul Haque

Abstract

Performance of several selftuning control algorithms were studied on simulated and realtime systems along with the test of robustness of the proposed controllers in the presence of disturbances. . The methods discussed in this article use data from a set response plot to make decisions about the performance of a specific selftuning control algorithm applied to our test plant. The methods require some judgment and we must be sure to be consistent in our evaluations to have value. The software developed for Selftuning controller implementation and research work was utilized for the study. To compare the regulation, the variance of the output, the variance of the input, standard deviation, IAE, ITAE, ISE, ITSE, etc. were computed. It has been observed that BSTR/BSTC provides better regulations while DMVR and PZAR require less control efforts and faster convergence. The set point tracking of all the selftuners were found to be better than the PIDC. A typical second order system model was considered and different selftuning control algorithms were applied by introducing several environmental conditions to the system and their behavior were observed under these environmental conditions. To compare the robustness of the controllers, structure and time delay perturbation was considered. The Microcomputer-based Software Package for Selftuning Control System Design was used in the simulation study and realtime applications. It has been found that Generalized Selftuning Controller (GSTC) is most robust compared to the other selftuners. The reason is attributed to the absence of integration term in it.

Index Terms— Selftuning, Regulator, Modeling, Identification, Performance Criteria, Robustness, Time Delay, Standard deviation, Variance.

1. Introduction

A controller is said to be selftuning if the controller parameters eventually converge to the values that would be used if the actual parameters were known. Broadly speaking, it is a form of adaptive control. Selftuning control process consists of (a) Parameter estimation; (b) Design

calculations; and (c) Regulation with the adjusted parameters. Many different control algorithms are formulated by using different combinations of (a), (b) and (c), which are classified as either explicit or implicit selftuners based on whether the parameters of the controller are indirectly estimated via the plant parameters or directly estimated [1].

The question of robustness is important for realtime applications because there could be un-modeled dynamics in the systems e.g., system delay could be assumed less than or greater than its actual value i.e., the system is under or over parameterized. There could be some changes in the dynamics of the system. These problems may arise in the realtime situations and it is expected that the controllers should work satisfactorily in this environment.

In order to achieve industrial acceptance, it is essential that selftuning controllers be robust enough to cope with the real world environment and conditions [9]. Limited study based on simulation was done to investigate the robustness of the said algorithms. The criterion set for the purpose is: (i) Perturbation in the structure; and (ii) Change in number of time delays

In this study the performance of different Selftuning algorithms based on the integral of the absolute magnitude of the error (IAE) criterion ISE, ITAE, ITSE. ISTAE or ISTSE, depending on the accuracy of the process model has been considered as applied to a realtime has been considered. An interesting comparison of this array of performance indices can be, found in [2]. Hereafter, the IAE criterion is considered like in [3] and [4] since it provides fast and fairly oscillatory responses compared to the integral of the square error (ISE) one.

2. Theory and Configuration of Selftuning Control

There are two major types of selftuners implicit and explicit type. In the implicit self-tuners the predicted model is formulated in such a way that the model parameters become the controller parameters. So in identifying the system parameters, essentially the controller parameters are estimated. It means that the controller parameters are directly updated and hence it derives the name implicit selftuner. On the other hand, in case of explicit self-tuners, first the parameters of a predicted model are estimated. Then from these estimated parameters, the controller parameters are computed applying certain design rules. So the controller parameters are indirectly determined and the controller is known as explicit selftuner. The Basic

Self-tuning Regulator (BSTR) of Astrom (1973) and the Generalized Self-tuning Controller (GSTC) of Clarke are implicit self-tuners and Detuned Minimum Variance Regulator (DMVR) and the Pole Zero Assignment (shifting) Regulator (PZAR) of Wellstead are explicit type self-tuners.

The selftuning owes its popularity to the recognition of the fact that certain simple algorithm could be combined with a regulator synthesis in an adaptive manner to a closed loop system with certain specified properties. The distinguishing factor of selftuning controller from that of adaptive controller is that in selftuning controller; the problem is simpler in the sense that the system to be controlled is to have either constant or slowly varying parameters.

In its essential forms self-tuning control combines the sequence of a suitable system model, estimating the parameters of the system from its assumed model and feeding the estimated parameters to controller [7,8,9]. Schematically, the implementation is shown in Fig.1

The parameter estimator acts on the process inputs and outputs and estimates of certain process parameters. The controller is simply a linear filter characterized for example by coefficient of its transfer function (TF). These coefficients are in general a nonlinear function of the estimated parameters.

As selftuning is a process of continuous re-tuning of the plant and process parameters, it is a more difficult challenge because the tuning and the control functions operate simultaneously. The controller must continue to maintain the process variable at a specified level as it tries to learn how the process variable reacts to control efforts (Fig.1)

Unfortunately, those are conflicting objectives. Maintaining a constant process variable deprives the tuning function of any useful insight into the behavior of the process, whereas exercising the process to see how it will react to a control effort defeats the purpose of the control function. Fortunately, there are times during the normal course of closed-loop operation when the control effort and the process variable fluctuate anyway, and most self-tuners are designed to take advantage of those situations.

Basic self-tuning regulators [7, 8, 10, 11, 12] are designed for a situation, where the control problem could be characterized as a minimum variance control problem. The basic STR was designed on a certainty equivalence principle. However it has limitations e.g., it cannot be used on

non-minimum-phase systems. Encouraged by its success and motivated its limitations Astrom and Wittenmark [13, 14, 15] devised a different -tuner following the similar approach but using pole/zero placement. They have suggested several of these algorithms, both implicit and explicit. Unlike other pole/zero assignment algorithms [16], the emphasis is on the servomechanism problem rather than the regulation problem.

The general configuration of an STR is shown in Fig.1. It consists of two parts. The first part is an estimator, which estimates the system parameters from input and output measurements at different instants of time. These estimates can be fitted into a system model of Fig.1 described by:

$$A(q)y(t) = B(q)u(t-k) + C(q)e(t) \quad (1)$$

where:

$$A(q) = 1 + a_1 q' + \ldots + a_n q^n \quad (2)$$

$$B(q) = b_0 + b,q' + \ldots + b_n q^{n-1} \quad (3)$$

$$C(q) = 1 + c,q' + \ldots + c_n q^n \quad (4)$$

y(t) is the output sequence, u(t) is the control sequence, e(t) is a sequence of white noise, k is the time delay and q is the backward shift operator.

The second part is the controller, which operates on system parameter estimates and computes the controller parameters. These parameters are then fitted into a controller model given by:

$$F'u(t) = G^*y(t) \quad (5)$$

The controller output depends on past controller sequence {u(t)} and system output sequence {y(t)}. The order of F* and G* is determined by the system order and time delay.

In the explicit self-tuner controller parameters are expressed in terms of system parameters and then estimated from input and output measurements. This arrangement gives an implicit self-tuner. The combined model becomes:

$$A^*y(t) = B^*u(t) + e^*(t) \quad (6)$$

The control sequence {u(t)} can be computed using estimates of the coefficients of A* and B*.

The above steps of estimation and computation of controller parameters are repeated at each sampling instant. In a realtime application one has to be sure that the calculation steps are executed within a sampling interval, otherwise the desired control will not be achieved. The sampling interval is crucial and it has to be chosen such that [5]:

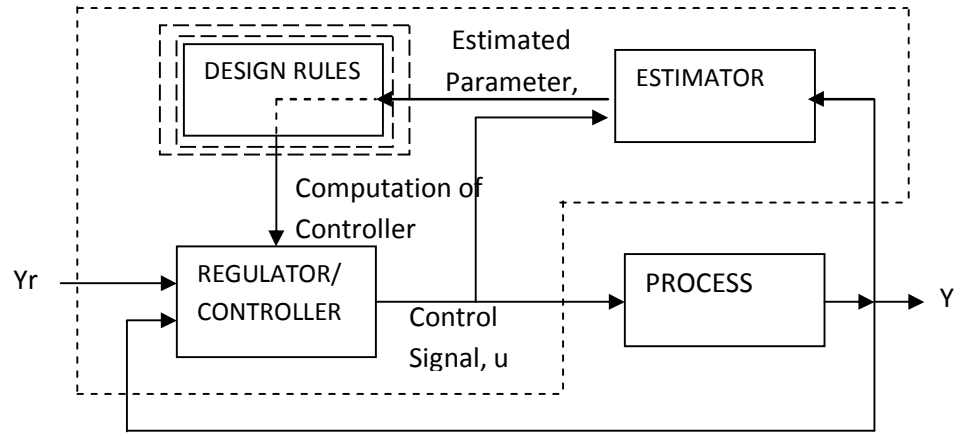

Fig 1: The general configuration of an STR

There are a number of well established design methods. In this study the following control methods were considered:

2.1 Minimum-variance Regulator or Basic Self-tuning Regulator (BSTC):

Here the objective is to minimize the variance of the output. The estimated model is given by

$$y(t) = -A'y(t-k) + B'u(t-k) + e(t) \quad (7)$$

and apply the control law

$$u(t) = -(\alpha/\beta)y(t) \quad (8)$$

where $\alpha = u(t)\ A'$ and $\beta = GB'$. In this case A' has n_v and B' has $n_u + k$ terms

2.2 Generalized Self-tuning Control (GSTC):

In this case estimated model, is given by

$$\alpha\ y(t) + \beta\ u(t) + Hw(t) + dc = 0 \quad (9)$$

The generalised output to be minimised is given by

$$\Phi (t + k) = y(t+k) - w(t) + \lambda u(t) \quad (10)$$

The control law is given by

$$u(t)= \{ \alpha y(t) + Hw(t) + dc\}/ \beta \quad (11)$$

2.3 Detuned Minimum-variance Regulator (DTMVR):

In this case, the predicted model is given by

$$y(t) = -A'y(t) + B'u(t) + e(t) \quad (12)$$

and the control is given by

$$u(t) = (\alpha/ \beta)y(t) \quad (13)$$

where $\alpha = T - A'$ and $\beta = B'$

A' has n_y terms and B' has $n_u + k$ terms. T is a polynomial chosen by the designer to locate closed loop poles at desired locations.

2.4 Pole Zero Assignment Regulator (PZAR)

In case of pole shifter, the predicted model is given by

$y(t) = -A'y(t) + B'u(t) + e(t)$ and the identity to be resolved is given by

$(1+A') + q^{**}(-k)B' = T$ and the control law is given by

$u(t) = -[\alpha/\beta]y(t)$

Here A' has n_y terms and B' has n_u terms.

Response polynomial or the detuning polynomial T is chosen by the designer according to the number of poles/zeros to be assigned/ shifted and the desired closed loop system response.

3. Implementation Consideration

System Modeling: The starting point for any controller design is an explicit assumption that the controlled process/system can be represented by a linear mathematical model in the form of a transfer function (TF) or corresponding difference equation (or differential equation for continuous time systems) having known its parameters a., b., c., d and the time delay k [k > 1]; the general form of the equation being:

$$\sum_{i=0}^{N} a_i y(t-i) = \sum_{i=0}^{N} b_i u(t-k-i) + \sum_{i=0}^{N} c_i.e(t-i) + d \qquad (14)$$

Here, u and y are the scalar input and output of a .SISO controlled

The aim of a self-tuning algorithm is to provide a digital controller for a system which is, in most of the cases, itself a continuous time process. In this process, it is assumed that the controlled process can be represented by a linear mathematical model in the form of TF or a corresponding difference (or differential equation for the continuous time system) with constant coefficients a_i., b_i., c_i, d and time delay k ($k > 1$). The selection of a proper model structure is the necessary first step to the selftuning regulator design. However, this is not necessary for a SISO system and it is then possible to concentrate on the model of a given structure. As the control will be implemented by a digital computer, [appropriate I/O model of the system is chosen as a difference equation of the form given in eqn.(1).

For SISO systems u_t and y_t will refer to the scalar input of a SISO controlled process. Unlike State Variable Form (SVF) the difference equation has unique system representation.

In this study, the control system considered for comparison of functions and performance are:

I. The Basic Selftuning Regulator (BSTR)
II. The Generalized Self-tuning Controller (GSTC)
III. The Detuned Minimum Variance Regulator (DMVR)
IV. The Pole-Zero Assignment (Shifting) Regulator (PZAR); and
V. The traditional three-term PID controller

The three-term PID controller was included in order to enable the users to compare the performance of the self-tuning algorithms with that of the conventional three term PID controller. Also, in case of algorithms 1,3, 4 and the three term PID controllers, provision has been made to modify the algorithm to incorporate set point for experimentation.

The system models used in this work are completely discrete with respect to time in the sense that they receive and send out discrete data only, as in the case of a digital controller or digital computer, self-tuning control is generally implemented on a digital computer, provision has been made in

the package to convert a system from a continuous-time to a discrete-time model. If the user has a continuous transfer function (TF) model or state variable (SV) model of the system, the software package can be used to transform the system to discrete model.

4. Implementation Processes

As has been stated earlier, the self-tuning is a form of adaptive control where the parameters of the controllers are automatically tuned by the algorithm with the changes in the plant environment due to different kinds of disturbances. Therefore, for implementation, the parameters of a predicted model both in the implicit and in the explicit algorithms are to be estimated. The system model for the purpose is given as:

$y(t) + ad)y(t-l) + ... + a(n_a)y(t-n_a) = b(1)u(t-k-l) + ... + b(n_b)u(t-k-n_b) + b(1)u(t-k-l) +... ... ..+ b(n_b)u(t-k-n_b) + c(0)e(t) + c(l)e(t-l)+...+ c(n_c)e(t-n_c) + . . . + c(n_c)e(t-n_c)$ (15)

where n_a = order of A polynomial; n_b = order of B polynomial and n_c = order of C polynomial.

Both the implicit and explicit types of selftuning control systems to simulated and realtime processes have been applied. For the implicit type of self-tuners, the predicted model has been formulated in such a way that the model parameters become the controller parameters. So in identifying the system parameters we essentially estimated the controller parameters. It means that the controller parameters are directly updated and hence the name implicit self-tuner. On the other hand, in case of explicit self-tuners, first the parameters of a predicted model are estimated. Then using these estimated parameters, the controller parameters have been computed applying certain design rules. So the controller parameters were indirectly determined and hence the controller is known as explicit self-tuner. The Basic Self-tuning Regulator (BSTR) of Astrom (1973) and the Generalized Self-tuning Controller (GSTC) of Clarke are implicit self-tuners and Detuned Minimum Variance Regulator (DMVR) and the Pole Zero Assignment (shifting) Regulator (PZAR) of Wellstead are explicit type self-tuners.

5. Study on Simulated Systems

The following systems were chosen for simulation study using various Selftuning control techniques mentioned in the previous section.

System 1: A second order system with SSG = 7.5 and oscillating behavior. The system model is given as:

$G(z) = (b_1 z^{-1} + b_2 z^{-2})/(1 + a_1 z^{-1} + a_2 z^{-2})$

where $a_1 = -1.5$, $a_2 = 0.7$, $b_1 = 1.0$, $b_2 = 0.5$ and $Tg = 2$ sec.

System 2: Unstable system with non minimum-phase behavior

$G(s) = K/[(1+T_1 s)(1+T_2 s)]$

$K = 1, T_1 = 4$ secs and $T_2 = 10$ secs.

$G(z) = (b_1 z^{-1} + b_2 z^{-2})/(1 + a_1 z^{-1} + a_2 z^{-2})$

The parameters of the system sampled at Ts =1, 4, 8 and 16 respectively are given below:

	1	4	8	16
a1	1.68364	-1.0382	-0.58466	-0.22021
a2	0.70469	-0.24667	0.06081	0.00370
b1	-0.07289	-0.07357	0.13201	0.55333
b2	0.09394	0.28197	0.34413	0.23016

System3: $y_t = 1.3\ y_{t-1} - 0.3\ y_{t-2} + 0.37\ u_{t-1} + 0.26\ u_{t-2}$

6. Discussions of the Results of Simulation Studies

A simulation study of the above examples was made using the software package developed to investigate the performances of the algorithms [1]. Figs. 6.3 to 6.11 in ref. [8] show the typical time histories of the control signal u(t), the output signal y(t), the parameters θ(t), the generalized output, Φ(t) where applicable, noise signal v(t) and the prediction error e(t). When self-tuners were subjected to the same disturbance of random noise with zero mean and standard deviation $\sigma = 0.3$, these time histories depict performance of the different algorithms against disturbances.

The third process considered for simulation purpose is a second order process with one of its open-loop pole outside the unit circle. It is found that the variance of the output around the zero operating point is large in the case of BSTR and PZAR shown in Figs.7a, 8a, 9a of Appendix lV in ref. [1] with output signal being rapidly varying in the case of PZAR. However, the control effort needed by PZAR is less compared to BSTR Figs.7b and 6.9b of Appendix III in ref. [1]. Very good

set point tracking is observed by using GSTC and the generalized output error is between +0.5 and -0.5, although the control signal is rapidly varying shown in Fig.6d and 6c of Appendix lV respectively of ref. [8]. DMVR did not work well for this process as has been shown in Fig.8 in Appendix-III [1].

7. Study on Real-time Processes

For the performance comparison of the Selftuning controllers on real-time processes, a laboratory thermal blower process was used as a Case Study. The term process is used to describe a physical or chemical change or conversion of energy, and includes the change of pressure, the temperature or speed of fluid, the rate at which a chemical reaction precedes, the level of liquid in a tank, etc.

7.1 Description of the Thermal Blower Process

In the thermal blower process, temperature of air flowing in the process tube is maintained at a desired value within the range of ambient temperature to 60^0 c. The laboratory blower process is a self-contained process and control unit with the basic characteristics of a large plant, enabling distance/velocity lag, transfer lag, system response, to be demonstrated. In this system, air drawn from the atmosphere by a centrifugal blower is driven past a heater grid and through a length of a tubing back to atmosphere. The purpose of the control equipment is to measure the temperature, compare a value set by the operator and a control signal which determines the amount of electrical power supplied to a correcting element. In this system, a heater is mounted adjacent to the blower. The elements which form the system are shown in Fig.3.

The main control objective of this process is to keep the temperature to a constant desired value and to change the set point after some time. Implemented regulators were connected and tested with the thermal blower process. Although this is a simple laboratory unit, it demonstrates most of the characteristics of a typical industrial process and is more realistic than a simulation

The Selftuning controllers were implemented on an IBM PC interfaced to the process via an AD/DA card (Tecmar, Modules DT5701 and 5712). The A/D converter (samples) the process output at each sampling interval and the values are input to the self-tuner as a regulation variable. The D/A converter convert the digital control variable computed

by the algorithm in the computer to an analog signal and send it to the process as a manipulated input.

The instrument contains integrated circuits and operational amplifier having self contained power supplies.

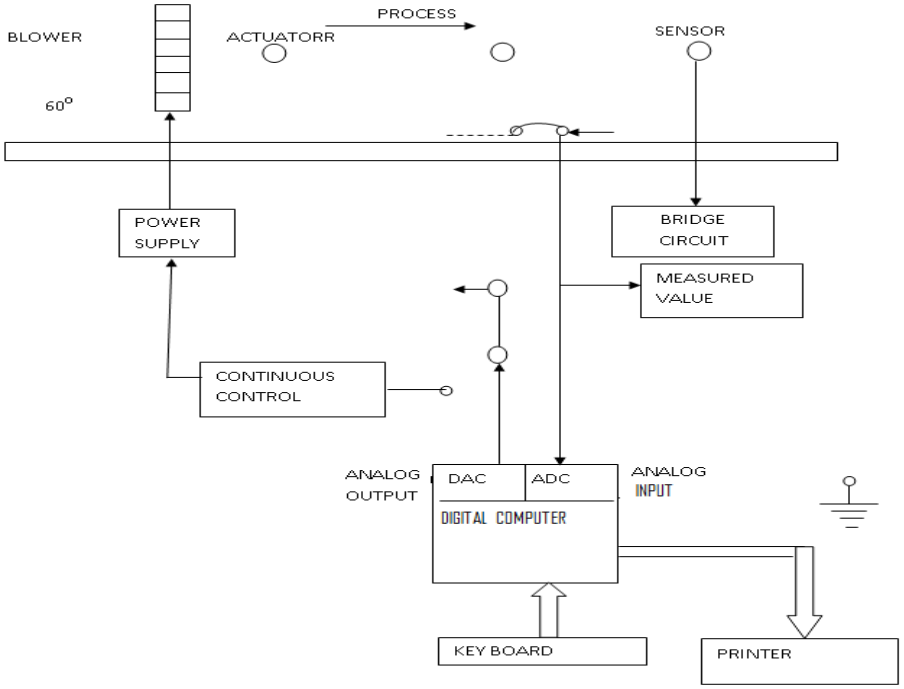

Fig. 3: Configuration of Micro-computer Control System.

The sensor is a bead the rmistor fitted to the end of a probe that can be inserted into the air flow stream at any of the 3 points along the tubing and it forms an arm of a dc bridge which is in balance at 400C. The bridge output voltage varies from 0 to +10 volts for an air temperature change of 300 C. The output from the measuring element can be monitored at socket (Y) on the front panel. The measured value of the temperature, θ0 is the output signal from the measuring element corresponding to the value of the controlled condition. The set value, θi is the value of the controlled condition to which the automatic controller is set. The internal set value control can be used to raise the process air temperature up to 600 C. The set value may be adjusted externally by applying a voltage between 0 and -10v to a socket, on the front panel, a negative going change in voltage producing a rise in temperature.

A summing amplifier is used to compare the measured value from the amplifier with the set value. The output from the summing amplifier represents the deviation and is monitored at a socket' on the front panel. The difference between the measured and the set value is given by

$$\Theta e = \theta_0 - \theta_i \quad (15)$$

A signal proportional to a deviation is applied to the controlling element, which then generates a control signal (0 to l0v) for transmission to the correcting unit. The controlling element can be switched to give continuous or two-step (on-off) control. The control signal is monitored at a socket on the front panel.

In this system, the actuator (motor element) is a variable power supply which gives an electrical output between 15 to 80 watts as determined by the control signal, which directly affects the controlled condition. The correcting element is an electrically heated wire grid, to which an input from the motor element is applied. Heat is transferred from the grid to the moving air. The rate of heat transfer is dependent mainly on the heater temperature and the air flow velocity. The Automatic Controller comprises the measuring, comparing and control elements and Correcting Unit comprises the actuating and correcting elements.

A change to the condition of a process affects the detecting element after a time interval which is dependent on the velocity of the process and the distance between the point of change and the detector. This time interval L is the distance / velocity or transport lag given by the equation

L=[Distance/Velocity]

It represents a pure time delay, there being no change in the magnitude or form of the signal.

The response of the detector to a step change in heater power is affected by two time lags: a distance/velocity lag, which has no effect the form of the input signal and the transfer lag, which does affect the form of the signal. In any stage of a thermal process where heat is transferred through thermal resistance to or away from a thermal capacity, the temperature rise is exponential to a step change in the input. It reaches 63.2°o of its final value V_f, after time T, which is exponential lag of that stage.

Any disturbance to the process that may occur on the supply side or the demand side of the system causes a change in the controlled condition. The supply side disturbance may be caused by:

1. Changes of inlet air flow,
2. Ambient air temperature,
3. Supply voltage to the heater.

Change in the set value provides a convenient means of assessing response of the system to different forms of disturbances. In the present work, since the set value is given by the computer, it is a simple task to add a sine or square wave to the set point for a certain period and then observe the performance of different controllers.

7.2 Modeling Thermal Blower Process

From step response of the system, it has been observed that the system (the laboratory blower process) is of second order in nature with some delay. So, assuming a second order model for the blower process problem is formulated to study the behavior of different selftuning controllers on the thermal blower process. The assumed model of the system relating the input, u(t) to the temperature output, y(t).:

$$[y(s)/u(s)] = [K/((1+sT_1)\ (1+sT_2)) \qquad (16)$$

This approximate model equation is the starting point for the self-tuning identifier and hence the controller design.

For the step response of the blower system, it was found that there is time delay in the system response and this should be taken into account in the digital control law. Hence, the modified model of the system will be

$$[y(s)/u(s)] = Ke^{-\tau s}/[(1+sT_1)\ (1+sT_2)] \qquad (17)$$

8. Discretizing the Continuous Time Model

Before the controlled system could be implemented in computer, the system mode must be discretized by sampling the input and output of the continuous time system model at instant t=kTs, where Ts is the sampling period. The choice of a sampling period is critical in self-tuning control and to investigate its effect on control performance, system models are required at different sampling intervals [13]. Then using Z-transform table, appropriate to a system with partial time delay, the discrete time model of the system is found to be:

$$Y(z^{-1})/u(z^{-1}) = K[(T - \tau)z^{-1}/T + \tau z^{-2}/T]/[(1 - e^{-T_1 Tz-1}) (1 - e^{-T_2 Tz-1})]$$

$$= [b_1 z^{-1} + b_2 z^{-2}]/[\ 1 + a_1 z^{-1} + a_2 z^{-2}] \quad (18)$$

where b1 = (T - τ)/T, b_2 = K τ/T, $a_1 = -(e^{-T_1 T} + e^{-T_2 T})$ and $a_2 = e^{-(T1 + T2)}$ (3a & 3b)

Three self-tuning algorithms were applied to the system successfully. The experiments were run without internal noise generator. In all cases, satisfactory results were obtained (Figs.8 -13) in ref.[1]. The process output sustained setpoint and load disturbances in all cases.

9. Performance Comparison

ISE penalizes the response that has large errors, which usually occurs at the beginning of the response because the error is squared.

ITE penalizes a response which has errors that persist for a long period.

IAE treat all errors in a uniform manner thus it allows larger deviation than the ISE.. In general, ITAE is preferred integral error criterion since it results in the most conservative controller settings

The performances of selftuning controllers are summed up in Table1. Table -.1 shows the performances of the self-tuning controllers and PID controller based on various criteria like mean, standard deviation etc. of the output, y, and input, u signals and various performances like Integral of the Absolute Magnitude of the Error (IAE), Integral of the Squared Error (ISE), Integral of the Time Multiplied by the Squared Error (ITSE). Desired output was set to 5.0V [Equivalent to 40°C].

Table1: Showing the Performance Comparison of Different Selftuning Controllers

ALGORITHMS / CRITERIA		PIDC	BSTR	GSTC	DMVR	PZAR
MEAN	Y	5.017471	5.047617	4.48897	5.050538	5.036693
	U	7.432138	6.613423	6.769391	7.03217	6.063694
VARIANCE	Y	0.00396797	0.003164643	0.2538204	0.05239655	0.1028029
	U	0.00462315	0.003515537	0.252334	0.05345906	0.1028732
STANDARD DEVIATION	Y	0.0629919	0.05625516	0.50232859	0.2289029	0.3207385
	U	0.06799377	0.05929196	0.5023286	0.2312121	0.3207385
Mean Square Error		0.00427323	0.00543147	0.5502068	0.0549506	0.1041493
Mean Square Deviation		0.1752593	0.07828808	0.8770794	0.1186848	0.4309116
IAE		0.115589	0.09736141	0.75109	0.02358938	0.2771861
ITAE		4544.296	4035.466	24873.86	8149.136	11778.72
ISE		0.1891798	0.1609912	1.228991	0.2677553	0.341279
ITSE		8488.928	7346.045	49801.83	11568.79	15453.99

10. Discussions on the Performance Study Results

From the experimental presented in the form of Table (Table1) it is observed that mean and variances of the output and the input are noticeably less in case of BSTR and PIDC. In terms of these measures the performances of BSTR and PIDC are similar to the standard deviation being somewhat higher in case of PIDC. IAE, ITAE, ISE, and ITSE are lowest in case of BSTR, PIDC being the next lowest. So, from these considerations BSTR performs better than all the self-tuners for the blower process and its performance is better but somewhat closer to PID controller.

It is also observed that DMVR and PZAR need less control action for the same set point. In both of these algorithms, some or all the poles/zeros are assigned by the designer. The algorithms are conservative in the sense that, they do not directly minimize any cost function but merely make a compromise between the set-point tracking, disturbance rejection and smooth control.

Large offset is observed in case of GSTC. It may be due to the fact that it has little integral action. Steady State Error is also found to be higher in case of GSTC for a fixed reference input.

11. Robustness Considerations

From the dynamic behavior of different self-tuners both on the realtime and the simulated systems under certain disturbance conditions it has been found that the self-tuners are capable to keep the system output to the desired level. This fact is well-known that self-tuners are designed for an assumed structure and for systems with constant or slowly time varying parameters. But the question remains to be answered as how robust the controllers are.

To study robustness issues in selftuning control systems, a typical second order system has been chosen for simulation using different selftuning algorithms mentioned in section 3. The issues considered for robustness study are the inaccurate time delay assumption and un-modeled dynamics of the system.

The actual system has a time delay 1 [KD=1] and order N=2. The study on time delay has been considered as it introduces poles at the origin and it contributes to the creation of non-minimum-phase system when discretized. Effect of un-modeled dynamics has been considered as it transfers wrong information about the system structure to the controller.

For this study, the model of the system is considered as

$$y(t) = [[z_{-1}(b_1+b_2\, z_{-1})]/[1 + a_1 z_{-1} + a_2 z_{-2})]]u(t) \qquad (19)$$

or

$$y(t) = [[b_1 z + b_2]/[z^2 + a_1 z + a_2]]u(t) \qquad (20)$$

First the effect of wrong assumptions of time delay is investigated. The above example with the correct structure is considered in section 6.4.1/pl48 where BSTR, GSTC, DMVR and PZAR are applied. The results of the simulation of this process indicate that these self-tuners can control the oscillatory system with high steady state gain (SSG).

Investigations have been carried out with time delay assumptions of time delay 0 and 2 [KD=0,2]. DMVR and PZAR did not work with KD=0 but BSTR and GSTC worked [See figs.32 and 33 respectively in Appendix-IV]. With KD=2 GSTC and PZAR worked. But PZAR settled after long time i.e., the transient is longer than that with the actual time delay [See figs.34 and 35 respectively]. BSTR and DMVR did not work with KD=2.

Next effect of perturbation was investigated. To investigate the model perturbation the following structure of the system is assumed:

$$y(t) = [[b_1 z + b_2]/[(z^2 + a_1 z + a_2)(z - z_1)]]u(t) \quad (21)$$

or

$$y(t) = [[z^{-1}(b_1 + b_2 z^{-1})]/[1 + a_1 z^{-1} + a_2 z^{-2})(1 - z_1 z^{-1})]]u(t) \quad (22)$$

This corresponds to a first order model perturbation, which also has the effect of introducing a discrete time delay. So, the delay for the above model becomes 2 [i.e. KD=2] .

From the model described by (6.30) it is found that it introduces an extra pure discrete time delay into the system. In order to investigate its effect on the control system the value of the pure time delay is chosen to be 1 and 2. The perturbed pole has been chosen to be -1 < z, < 1. The simulated results are shown in figs.19, 20, 21, 22, 25,26, 28, 30, and 31 with KD=1 and in figs.23, 24, 27, and 29 with KD=2 in Appendix-IV respectively [1]. Note that the assumed order of the system is incorrect in all of the cases [2 instead of 3]

It has been found that with -0.3< z 1 < 0.4 and KD=1 BSTR works (Figs. 19 and 20, in Appendix-IV) [1]. But with KD=2 BSTR does not work. With -0.4 < z] < 0.5 GSTC works for both KD=1 and KD=2. Figs.21, 22, 23 and 24 in Appendix-IV displays the results when the setpoint is 5.0 and fig.25 to fig.28 in Appendix-IV [1] displays the results for setpoint tracking. DMVR works with -0.2 < z, < 0.0 for KD=1 and with -0.2 < z1 < 0.0 for KD=2 [See figs.28 and 29 in Appendix-IV respectively]. PZAR works with -0.3 < z] < 0.5 for KD=1 in figs. 30 and 31 in Appendix-IV [1].. But with KD=2 it does not work.

Although simulation on one system cannot give us a conclusive evidence of the robustness issue which is still a subject of research, but it has been found out that GSTC is more robust than all the other self-tuners considered in this study. It appears that the introduction of integration term to reduce the steady state error has a bad effect on the robustness. In other words, there is a trade-off between robustness and the steady state tracking.

12. Conclusion

The methods discussed in this article use data from a set response plot to make decisions about the performance of a specific selftuning control

algorithm applied to our test plant. The methods require some judgment and we must be sure to be consistent with our evaluations to have value. To compare the robustness of the controllers, structure and time delay perturbation was considered. It has been found that GSTC is most robust compared to the other selftuners. The Microcomputer-based Software Package for Selftuning Control System Design The reason is attributed to the absence of integration term in it. However, the study on one simulated system cannot be conclusive. Further study on simulated and realtime systems is needed.

The different selftuning controllers were tested on simulated and realtime systems by using the software package developed specifically for the purpose. The investigation results obtained from these experiments demonstrates the feasibility of using the self-tuners for industrial process control. The Least Square Estimation techniques have been linked with different self-tuning control algorithms to obtain the proposed regulator parameters and compute the control signal.

The performances of different self-tuners on both simulated and realtime processes have been studied based on time histories, different performance-criteria such as IAE, ITAE, ISE, ITSE, SD etc. Also, the robustness issue associated with the algorithms has been studied in terms of time delay and first order model perturbation. In terms of mean, variance, standard deviation, IAE, ITAE etc. it has been found that BSTR performs better than all the self-tuners and its performance is somewhat closer to PIDC.

From the dynamic behavior of different self-tuners both on the realtime and simulated processes it is observed that under different disturbance conditions the self-tuners are capable to keep the system output to the desired level.

From the investigation of robustness issue, it has been found that GSTC is more robust than all other self-tuners with PZAR as next to it in this issue.

In the future works, other performance tools and measures like moving average, moving variance, cross and auto-correlation, power spectrum may be incorporated for simulation and realtime applications.

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Wastes Analysis in Traditional and Lean System to Reduce the Production Time in Apparel Industry of Bangladesh

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Abstract

Waste can be considered as anything in the industry which does not have value or does not add value to the finished product. Waste can be in the form of unnecessary output, input or processing. It is something the customer will not pay for. So it became very noteworthy to identify waste and its effects on productivity and manufacturing cost of RMG products. In order to survive in today's fiercely competitive market the RMG manufacturers have come to realize that the traditional mass production concept has to be adapted to the new ideas of lean manufacturing. Lean is a production practice or the set of management practice that creates more value with fewer or less wastes. The objective of this research is to find out how lean manufacturing can be used to achieve the customer demand on time by eliminating non value added work; minimizing the work in process inventory and rework percentage creating flexibility of style changeover and a pool of multi-skilled operators who can respond quickly for changing the style by comparing it with traditional system ultimately affecting overall production and cost.

Key Words: waste, lean system, traditional system, seven wastage, non-value added work, wasted time.

1. Introduction

In this competitive textile world, the most desirable goal for each manufacturer is to provide the best quality product within the shortest lead time and the possible lowest cost. Cost increases with the increases of wastage in production system. Therefore, an easy way to minimize the cost and to boost the profit is reducing wastes. Wastes are something that add no value to the product. Industries apply different systems to keep pace with the incremental competition conditions and changing consumer demands. A popular production system named 'lean manufacturing' identifies seven types of wastes within the entire production facility. Lean production is a multi-dimensional approach that encompasses a wide variety of management practices, including just-in-time, quality system, work teams, cellular manufacturing, supplier management, etc. in an

integrated system (Kuo T, 2008, 1).Waste is anything other than the minimum amount of equipment, materials, parts, and working time that are essential to production (Dal V., 2013, 16). Lean management and lean production system can eliminate the seven types of wastes to create value for the supplier as well as for the client which ultimately reduces the production cost. The seven wastes of Lean Manufacturing are transport, inventory, motion, waiting, over production, over-processing and defects. Transport is one of the seven wastes of lean manufacturing; it is the movement of products from one location to another. In case of lean manufacturing this waste cannot be fully abolished because there are few areas where transportation cannot be eliminated but *the* lean system reduces transportation time. In a lean manufacturing environment, waste of inventory is considered one of the 7 major wastes. When the layout of a work area is excessively large, often as a byproduct of overproduction, distances increase which leads to more wasted motion. This waste is defined as people or things waiting around for the next action. Producing items more than required at given point of time is over production. In simple words producing excess inventories is over production. Over-Processing waste is an extra effort or activities that add no value from the customer perspective. By adding work that is not required, over-processing costs money with regards to the time of work force. A defect is any error in a process that makes a product or service less valuable to a customer, or that requires additional processing to correct the defect.

2. Literature Review

The popular definition of Lean Manufacturing and the Toyota Production System usually consists of the following; it is a comprehensive set of techniques which when combined allow you to reduce and eliminate the wastes. This will make the company leaner, more flexible and more responsive by reducing waste (Wilson, 2009, p. 29-30). Lean is a systematical approach to identify and eliminate waste through continuous improvement following the product at the pull of customer in pursuit of perfection (Choudhary 2012, 185), (Nash, Poling and Ward, 2006, p. 17). To achieve these, the lean production philosophy uses several concepts such as one-piece flow, kaizen, cellular manufacturing, synchronous manufacturing, inventory management, pokayoke, standardized work, work place organization, and scrap reduction to reduce manufacturing waste (Russell and Taylor, 1999). Lean production reduces all forms of non-value added activities in organizations and improves its performance

(Ferdousi and Amir; 2009; 106). These wastes are included within the cost of products, either increasing the cost of product or reducing the profit of the industry. In addition to improve profit minimizing, waste has a major impact on customer's satisfaction. A very brief description of the most common lean tools is given below (Monden Y, 1998; Feld W, 2000; Abdulmalek FR, 2007,223; Czarnecki H, 2011; KalaoğluFS, 2007,93);

2.1. **Cellular Manufacturing:** It organizes the entire process for a particular product or similar products into a group (or ''cell''), including all the necessary machines, equipments and operators. Resources within cells are arranged to easily facilitate all operations.

2.2. **Just-in-time (JIT):** A system where a customer initiates demand which is then transmitted backward from the final assembly all the way to the raw material, thus ''pulling'' all the requirements just when they are required.

2.3. **Kanbans:** A signaling system for implementing JIT production.

2.4. **Total Preventive Maintenance:** Workers carry out regular equipment maintenance to detect any anomalies. The focus is changed from fixing breakdowns to prevent them. Operators are included in maintenance and monitoring activities in order to prevent and provide warning of malfunctions.

2.5. **Setup Time Reduction:** It continuously tries to reduce the setup time on a machine.

2.6. **Total Quality Management:** It implies a system of continuous improvement employing participative management that is centered on the needs of customers. Key components are employee involvement and training, problem-solving teams, statistical methods, long-term goals, and recognition that inefficiencies are produced by the system, not people.

2.7. **5S:** Focuses on effective work place organization and standardized work procedures.

2.8. **One Piece Flow:** To minimize work-in-process, operators should focus on completing one part through the process before starting on the next.

These wastes reduce production efficiency, quality of work as well as increase production lead time. Waste sources are related to each other and elimination of one source of waste can lead to getting rid or reducing

another source of waste. According to David Magee different kinds of wastes in a process can be categorized in *the* following categories (Magee, 2007, 67).

1. Overproduction – Producing items more than required at given point of time i.e. producing items without actual orders creating the excess of inventories which needs excess staffs, storage area as well as transportation etc.

2. Waiting – Workers' waiting for raw material, machine or information, etc. is known as waiting and it is the waste of productive time. The waiting can occur in various ways for example; due to unmatched worker/machine performance, machine breakdowns, lack of work knowledge, stock outs etc.

3. Unnecessary Transport – Carrying of work in process (WIP) to a long distance, insufficient transport, moving material from one place to another is known as the unnecessary transport.

4. Over Processing – Working on a product more than the actual requirements are termed as over processing. The over processing may be due to improper tools or improper procedures etc. The over processing is the waste of time and machines which does not add any value to the final product.

5. Inventory - This includes excess raw material, WIP, or finished goods causing longer lead times, obsolescence, damaged goods, transportation and storage costs, and delay. Also, the extra inventory hides problems such as production imbalances, late deliveries from suppliers, defects, equipment downtime, and long setup times.

6. Unnecessary Movement – Any wasted motion that the workers have to perform during their work is termed as an unnecessary movement. For example; movement during searching for tools, shifting WIP etc.

7. Defects – Defects in the processed parts is termed as waste. Repairing defective parts or producing defective parts or replacing the parts due to poor quality etc. is the waste of time and effort.

The first step of the research is to choose a particular facility or industry which has enough work flow to be assessed in their traditional system of manufacturing and implementing lean as the target for improvement. The next step is to draw a current state map that is essentially a snapshot capturing how things are currently being done in case of their traditional

system. This is accomplished while walking along the actual process, and provides one with a basis for analyzing the system and identifying its weaknesses. Then lean system was implemented by its essential tools and techniques. Finally the improved or changed state mapping was collected and documented. Besides, because of technical causes more wastage were generated at different sections of the industries due to following reasons:

- Lack of attention of workers towards work,
- Lack of quality knowledge
- Improper co-ordination among different sections
- Lack of proper supervision
- Defective fabrics and accessories. (Mazumder, 2015, 15)

3. Data Analysis and Discussion

Transport Analysis

(Total available hour per day 800, number of worker 8, available working hour per day =10)

Table 1: Transport Analysis of cutting, sewing and finishing section of an apparel industry

No.	Department	From	To	Distance in feet	What	Quantity (pcs)	Why	Methods of Transport	Workers	Time (Min)	Frequency (how many time a day	Total minutes lost/day
1	Cutting	Relaxation store	Cutting	30	Fabric	40000	For cutting	Manual	2	0.5	280	280
2		Cutting	Numbering	33	Cuttings	40000	For numbering, bundling and replacing	Manual	1	0.5	240	120
3		Numbering	Sewing	35	Cuttings	20000	For sewing	Manual	1	1	60	60
4	Sewing	Sewing	Iron	20	Garments	20000	For quality check	Manual	1	0.7	120	84
5	Finishing	Iron	Final QC	15	Garments	20000	For ironing	Manual	1	0.5	500	250
6		Final QC	Packing	16	Garments	20000	Packing	Manual	1	0.4	20	8
7		Packing	Store	95	Garments	20000	Storing	Manual	1	5	30	150
Total:							**952**					

Time Required for Traditional System: 952 minutes per day or 15.87 hours per day or 412.62 hours per month

Time Required for Lean System: 412.62 x 0.20 = 82.52 hours per month

Over Processing

(Total available hour 8400, number of worker 840, available working hour =10)

Table 2: Analysis of over processing

Production/days						46,800 pieces
Serial	Activities	Department	Hourly Quantity	Daily Quantity	Minute/pc	Minute per day
1	Front back match	Sewing	4680	46800	0.400	18720
2	Bundle handling		4680	46800	1.03	48204
3	Thread cut		37430	374300	1.100	411730
4	Neck tack		4680	46800	0.080	3744
5	Piping tack		4680	46800	0.200	9360
6	Piping cut		4680	46800	0.070	3276
7	Quality check		4680	46800	0.200	9360
Total						**504394**

Total Loss in Traditional Ssystem

504394 minutes per day or 8400 hours/day or 218400 hours per month

Lean system saves 100% of this time.

Defects(Total available hour 8400, no of worker 840, available working hour =10)

Table 3: Defects Analysis in traditional and lean system

Total Available Labor /Sewing Line	35				
Line	Daily Average Mistakes	Daily mistake %	Average Cycle Time per mistake (Minute)	Total Time Waste (Minutes) for all lines	Minutes Waste per Day-Worker
Traditional	247	14%	1.76	435	12.45
Lean	102	5%	1.76	179.5	5.13

Total Wasted Time

Traditional System: 435 minutes/dayor 7.25 hours per day or 188.5 hours per month

Lean System: 179.5 minutes/day or 3 hours/day or 78 hours/month

Over production(Total available hour 8400, number of worker 840, available working hour =10)

Table 4: Analysis of Overproduction for Varieties of Pproducts

Products	Monthly Shipped Quantity	Monthly Ordered Quantity	Monthly Cut Quantity	Cut to Ship Ratio	Order to Ship Ratio	Difference Cut to Ship	
Legings	40053	39990	41961	95%	100%	1908	
Coat	43398	48453	46952	92%	90%	3554	
Jogger	6545	6927	6930	94%	94%	385	
Tee Shirts	594477	611677	622487	96%	97%	28010	
Shorts	13022	13033	13264	98%	100%	242	
	697,495	720,080	731,594	95%	97%	34099	

Cost of over production (Month)							
Total Available Labor Sewing		840	Working days per month		26		
	Labor cost per minute (estimate)			$ 0.006			
Products	Difference Cut to Ship	Cycle Time in Manufacturing	Cost of Raw Materials/Piece	Cost of Labor per Piece	Total Cost of raw mtl in $	Total Cost of Labor in $	Losses of Labor in minutes
Legings	1908	6	$ 0.875	$ 0.03	$1,670	$ 64	11,448
Coat	3554	37.2	$1.190	$ 0.21	$ 4,229	$743	132,209
Jogger	385	59.8	$1.270	$ 0.34	$ 489	$129	23,023
Tee Shirts	28010	7.6	$1.190	$ 0.04	$ 33,332	$1,196	212,876
Shorts	242	4.5	$0.800	$ 0.03	$ 194	$ 6	1,089
Total	34099				$ 39,913	$ 2,139	380,645

Required time in traditional system: 380,645 minutes/month or 6344.08 hours/month

Required time in lean system: 6344.08 x 0.40 = 2537.63 hours/month.

Order change over

(Total available hour 8400, number of worker 840, available working hour =10)

Table 5: Analysis of Order Changeover in Traditional and Lean System

	Month	1 changeover	1 sewing line	Month
Line type	Number of Changeovers in one month *(entire factory)*	Minutes Wasted per one Changeover per one sewing Line	Workers per one sewing line *(including sewing operators and helpers)*	Monthly Minutes wasted for all orders changeover
Traditional	25	638.3	43	15,958
Lean	25	15	35	375

Time Required in Traditional Line

15958 minutes or 265.97 hours per month

Time Required in Lean Line

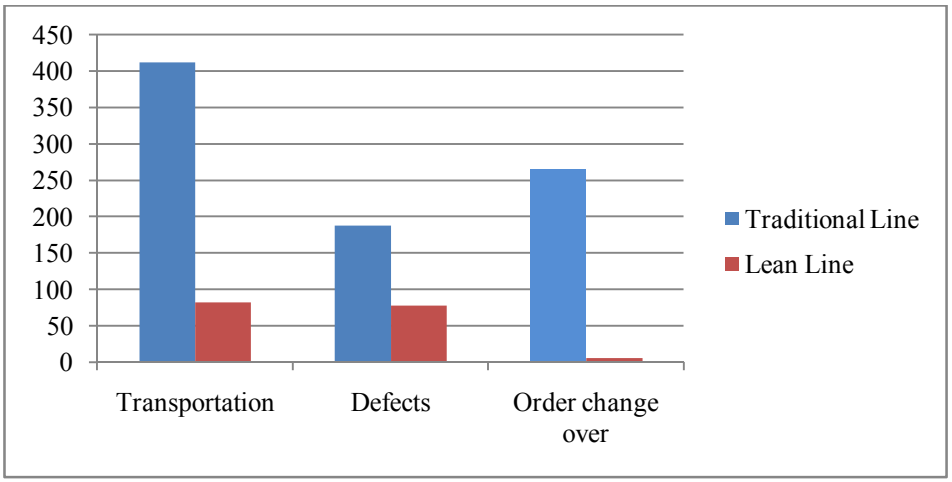
375 minutes or 6.25 hours per month

Comparison of wastage

Table 6: Comparison of various wastes in traditional and lean system.

Wastes	Traditional line	Lean line
Transportation	412.62 hours/month	82.52 hours/month
Defects	188.50 hours/month	78 hours/month
Over processing	218400 hours/month	0
Over production	6344.08 hours/month	2537.63 hour/month
Order change over	265.97 hours/month	6.25 hours/month

Graph 1: Barchart shows the comparison of various wastes in traditional and lean system.



3. Discussion

Finally, it can be said that traditional manufacturing system of apparel production requires more time which leads to extra labor, excess inventory and raw materials as well as an increase in high amount of production cost. This non-value added activity cuts the profit of any industry. Whereas, lean production system eliminates all this non-value added

activity and few essential non-value added activity smoothening the production system. Reducing the time indicates the less amount of lead time required for shipment purpose which is a major characteristic for progressing in this competitive textile sector.

4. Conclusion

Waste reduction is a challenge for industries like apparel industry in Bangladesh. Numerous practitioners of lean have tried to put their own stamp on the lean methodology and the seven wastes by adding other wastes. There is a wide range of additional wastes that are occasionally discussed in lean. Many of these ideas for adding new wastes provide a good emphasis on a particular issue in an organization. Often, though, they relate to ideas already embedded within lean and the original seven wastes. This study is carried out in Jinnat Apparels Ltd. (DBL Group) which is situated at Jinnat Complex, Sardagonj, Kashimpur, Gazipur. From this study, it is visible that applying lean system to eliminate wastes in apparel industries limits the cost of production, labor amount as well as production time can be reduced easily which increases profit to that industry. Findings of this research can be valuable and helpful to other similar apparel industries, who expect better production with quality and high marginal profit.

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Consumer Rights A Protection and the Necessity of Awareness: A Bangladesh Perspective

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Abstract

Consumer Rights Protection Act 2009 has been initiated and implemented solely for the consumer rights protection. The purpose of the study is to investigate the association of the gender and the level of consumption expenditure of consumer with the consumer rights protection awareness in the context of Bangladesh. The study finds that consumer rights protection awareness level is significantly biased on both gender and consumption expenditure. Males are more likely aware than females and the people from higher consumption expenditure are significantly more likely aware of consumer rights protection than the people from low consumption expenditure. In order to increase the level of consumer rights protection awareness of the female and of the people from low expenditure, the government or the other concerned organizations may conduct many necessary policies and campaign programs.

Keywords: Consumer, Rights, Protection, Awareness, Gender, Consumption, Expenditure, Bangladesh.

1. Introduction

1.1 Consumer Rights Protection

The concept of consumer rights got a shape since 1962 with the Consumer Rights Protection Movement and finally received world recognition with the observance of the World Consumer Rights Day on March 15 since 1983. For the purpose of protecting the consumer rights the United Nations assembly adopted the United Nations guidelines for consumer protection on 9th April, 1985 (Wan Jusoh, Othman, Nuruddin, and Ahmad, 2001). Since then all the member countries are following the guidelines and keeping the guidelines in mind some domestic legislations have been made by them in the related field. In the light of these guidelines Bangladesh pronounced the Consumer Rights Protection Act on 6th April, 2009, though a number of laws were existing with relation to consumer rights protection like Sale of Goods Act 1930, Penal Code 1860, Special

Power Act 1974, Bangladesh Food Ordinance 1959, Bangladesh Pure Food Rules 1967, Bangladesh Essential commodity Act 1978, Bangladesh Drug Control Ordinance 1982, Bangladesh Standard and Testing Institute Ordinance 1984, The Breast Milk Substitute (Regulation of Marketing) Ordinance 1984 and so on.

Bangladesh as a third world country is struggling a lot to ascertain the basic needs of its population. The constitution provides directly by Article 32 to the citizens of the right to live a safe life. This Article indicates that the citizen should be assured to live a safe life which covers the area of safe food too. Article 102 and Article 44 ensure the rights to be protected under the supervision of High Court division of The Supreme Court.

According to section 2 (20) of the Consumer Rights Protection Act 2009, consumers are entitled to take legal actions against any person who commits any of the following activities: if any person (a) sells or offers to sell any goods, medicine or service at a higher price than the fixed price under any law for the time being in force; (b) sells or offers to sell adulterated goods or medicine knowingly; (c) sells or offers to sell any goods containing any ingredient which is extremely injurious to human health and the mixing of which with any food item is prohibited under any law for the time being in force; (d) deceives consumers by untrue or false advertisement with the purpose of selling any goods or service; (e) sells or delivers properly any goods or services sold and promised inconsideration of money; (f) sells or delivers less than the offered weight to the consumers while delivering or selling any goods; (g) uses the weight stone or any other weight measuring instrument used for measuring weight in selling or delivering goods which shows more than the actual weight; (h) sells or delivers less than the offered amount while delivering or selling any goods; (i) uses the length measuring gauge or anything else used for measuring length in selling or delivering goods shows more than the actual length; (j) makes or manufactures any fake goods or medicine; (k) sells or offers to sell goods or medicine the date of which has expired; (l) does an act which may endanger the life or security of the consumer and which is prohibited by any law for the time being in force.

According to Cambridge Dictionary awareness is an understanding of a situation or subject at the present time based on information or experience. Law aids the vigilant: the laws serve persons who are vigilant and not those who sleep upon their rights (Islam, 2011). If the consumers

know about the punishable anti-consumer rights activities as depicted in the Consumer Rights Protection Act 2009, institutions working for ensuring consumer rights like the Directorate of National Consumer Rights Protects or the Consumer Association of Bangladesh (CAB) and if they are willing to go for legal advice while they are facing anti-consumer rights activities, then they can be said as aware of consumer rights protection.

In Bangladesh the level of awareness of the people about their own rights protection that the state provides as a consumer, is a matter of great importance since the implementation of Consumer Rights Protection Act 2009 as this Act is dedicated for the protection of consumer rights only. Therefore, there is a necessity of conducting research on the awareness of consumer rights protection in Bangladesh.

1.2 Objectives of the Study

The objective of the study is to find out whether the level of consumer rights protection awareness has a significant relationship with the gender of consumer. Another objective of the study is to determine whether different levels of consumption expenditure have significant relationship with consumer rights protection awareness.

2. Literature Review

For reviewing the literature some well-known national and international research works have been taken into consideration, which are stated bellow:

Alain (1978) stated that medical costs were badly affecting public finances. Direct economic regulation creates trouble to the performance of the physicians. The author suggested the government to take health plans which would be beneficial to both the physicians and the consumers. Kristine (1992) examined the practice in the consumer movement, which included facilities provided to the old, disabled, and mentally incapable people. The author had drawn a Comparison to point out the philosophical differences between medical-rehabilitation and independent living paradigms. The author suggested more participation by the work holders for the betterment of present situation. Carrigan and Attalla (2001) attempted to investigate that whether there is any relation between consumer purchase and marketing ethics or not. And it is found that marketing ethics does not have any remarkable impact on the consumer

purchase. It is also found that the experience and reliability is much more effective than the marketing ethics.

McCabe (2001) analyzed consumer rights in the context of Australia and the protection mechanism through legal system. The author attempted to investigate whether the laws providing protection of consumer rights were exhaustive or not. It was found that people are unaware of their rights and were badly mislead by the producers. Alan (2006) attempted to provide scientific and consumer models of recovery for the schizophrenia patients in the United States as they were also empowered to exercise their right to proper medical care as consumer. Chapman and Liberman (2006) explored issues involved in the meaning of 'adequately informed' smoking and discussed some of the key policy and regulatory implications. They used the idea of a smoker licensing scheme under which it would be illegal to sell to smokers who had not demonstrated an adequate level of awareness as a device to explore some of these issues. They also explored some of the difficulties that addiction poses for the notion that smokers might ever voluntarily assume the risks of smoking. Zaman, Rahman, and Zannat (2009) aimed at finding out the loopholes of the existing laws of Bangladesh on consumer rights and to give proper suggestions thereof. The working of various consumer rights related institutions of Bangladesh are evaluated in this article with a positive approach to improve their quality and capacity to ensure consumer rights.

Shauhin (2009) investigated the relationship between consumer right protection laws and its practice by the manufacturers in California by studying the case laws and many more. It was found that the laws and institutions roughly overlook each other. Jacobs, Stoop and Niekerk (2010) stated that the existing special law provides discussion on the right to fair, just and reasonable terms and conditions and the right to fair value, good quality including explanations and critical analysis. This article, in particular, aims at evaluating these rights and to establish the extent to which consumer protection previously provided for under the laws existed. The article had investigated that the Act is written in favor of the consumer only. And it would not definitely be welcomed by the suppliers of products to be consumed. Paul (2010) examined what is the opinion of the leading consumers regarding consumer rights, government regulation, and individual responsibility in the credit card settings. The article finds out that four socio-historically shaped political concepts compete in this ideological space: individual autonomy, social equality, consumer

sovereignty, and corporate dominance. Chatterjee and Sahoo (2011) attempted to explore and identify consumer awareness regarding consumer responsibilities and Consumer Protection Act 1986. It was found that the consumers are almost unaware about the existing laws and their rights.

Krishnakumar and Sakthiventhan (2012) examined the consumer protection awareness at rural areas in India. They showed that the inhabitants in rural areas had lack of awareness of many facts that are of relevance for their own welfare. Malek (2013) intended to draw the attention of the government of Bangladesh to take necessary steps as per the findings of the research to protect the consumers from adulterated foods and to ensure food safety. Njuguna, Oloko, and Oyugi (2014) investigated the level of consumer rights awareness and the effect of consumer rights awareness on consumerism in Kenya and found a positive relationship between consumer rights awareness and consumerism. Nasreen and Ahmed (2014) conducted a study to investigate the range of food adulteration during 1995–2011 and consumer awareness in Dhaka city.The extent of food adulteration found to be high enough to warrant further action to control the situation. The majority of the consumers had no knowledge, relating to food adulteration. They suggested that publicizing the newly-passed consumer protection law, other existingfood adulteration-related laws, and different aspects of food adulteration via mass media could play a crucial role in raising consumer awareness.

Sabri (2014) stated that though there are a number of laws and mechanisms for consumer protection in Malaysia but these are not sufficient for the smart consumers in today's globalized world. But there could not be any specific model by which consumer rights could be implemented. For the purpose of better protection the only way is the effort of the parties concerned, i.e. the government, traders, consumers and non-governmental bodies. They should ensure that Malaysian consumers are well protected. Valant (2015) examined the tools available to ensure the protection of consumers in the European Union. European Union consumer protection legislation and tools which are used to monitor and improve the protection of European consumers are not adequate. The paper provides a snapshot of the main consumer policy developments in recent years, together with success stories, shortcomings and future challenges for legislators.

Previous studiesdo not cover the area of discussions on gender biasness and the consumption expenditure biasness on consumer rights

protection awareness in the context of Bangladesh. This is why the present study is undertaken to fill up the research gap. The study will help the policy makers to make policies with relation to consumer rights protection.

3. Research Methodology

3.1 Questionnaire and Research Designs

Gender and consumption expenditure are independent variables for the desired analysis. Male, female, and common gender are categorized under gender. On the basis of Gross National Income (GNI) per capita accounted as of the 1st July, 2016 published by the World Bank, the monthly consumption expenditure in BDT is grouped into four separate ranges: low, lower middle, upper middle, and high monthly expenditures according to the magnitudes of expenditure respectively. Monthly consumption expenditure is the expenditure that a respondent conducts monthly for any purposes. The dependent variable is the level of the awareness of consumer rights protection, which is constructed in the questionnaire by fifteen items in total. Among them twelve items are constructed from the anti-consumer rights practices as described in the Consumer Rights Protection Act 2009. Each of the twelve questions with relation to the twelve offences depicted in the Act is made to find out whether a respondent knows or does not know about a particular anti-consumer rights activity as a punishable offence. Another two items are prepared to know about the Directorate of National Consumer Rights Protects and the Consumer Association of Bangladesh (CAB) respectively from the respondents because these two organizations work particularly on consumer rights protection. Another question seeks the interest of going for the legal assistance in case of any violation of consumer rights.

All of the fifteen items show the level of knowing by the combinations of 'yes' and 'no' answers. For each respondent the number of 'yes' is counted where a respondent can say a minimum of zero 'yes' and a maximum of fifteen 'yes' and on the basis of this logic the level of awareness of consumer rights protection is defined as follows:

Table 1: Consumer Rights Protection Awareness Level Determination

Number of 'yes'	Likert scale	Awareness of consumer rights protection
0 and 1 to 3	1	Very low awareness
4 to 6	2	Low awareness
7 to 8	3	Medium awareness
9 to 12	4	High awareness
13 to 15	5	Very high awareness

The research also tries to find out if a respondent is not interested to go for legal support, then what should be the most probable reasons among the legal aid procedure is (1) complicated, or (2) lengthy, or (3) expensive, or (4) a provider of manipulated result.

3.2 Hypotheses of the Study

The null hypotheses of the study become:

Null Hypothesis 1: Gender has no relationship with consumer rights protection awareness.

Null Hypothesis 2: There is no biasness between consumption expenditure and consumer rights protection awareness.

3.3 Statistical Tests

Pearson's Chi-Square test has been used for finding out the association between the gender and consumer protection awareness and the association between consumption expenditure and consumer protection awareness. Cramer's V test hasbeen conducted for the depth of this association. Spearman's correlation and Kendall's Tau Btestshave been undertaken to understand the direction of the relationships among the variables.

3.4 Sample Size Determination

The standard deviation of the population of the mean value of consumer rights protection awareness is unknown. This is why a pilot study of a sample size of 10 is conducted. 5 males and 5 females from different expenditure groups are brought under this study. It is noted that the value of Cronbach's Alpha of the fifteen items defining the level of awareness of this trial study is 0.87. The 0.9944 is the standard deviation of the tiny sample, which is used as the proxy of the population standard deviation.

The standard variate at a 90 percent confidence level and an error of 0.1098 are assumed. Therefore, the desired sample for the analysis becomes 222.

3.5 Sample Collection

Researchers interviewed most of the respondents. Other respondents responded personally to a group of investigators and before the interviews all the investigators were well taught about the investigations as well as the objectives of the study. The investigators first explained the study to the respondents and then collected the data. Throughout August, 2016 the data were collected and Mirpur Thana in Dhaka city was selected for the place of sampling. People from common gender were not available to be interviewed during the period of sample collection.

Finally a sample of 222 is collected, where the number of female and male are 84 and 138 respectively. On the other hand, the people enjoying low, lower middle, upper middle, and high expenditures are 65, 84, 58, and 15 respectively. During the survey time male respondents were more convenient to answer the questions relative to female respondents.

3.6 Reliability of Test Instrument

The value of Cronbach's Alpha of fifteen items under the consumer rights protection awareness is 0.710. This confirms that the data set under the dependent variable is reliable. The value of 0.727 is found from the Kaiser-Meyer-Oikin test, which ensures that sample which is trying to measure consumer rights protection awareness level is sufficient. The factor loading shows that:

Table 2: Factor Loading of the Items under Consumer Rights Protection Awareness

Components of consumer rights protection awareness		Factor loading
Component 1	Know about the punishable offence of selling goods, medicine or service at higher price than fixed price	0.598
Component 2	Know about the punishable offence of selling adulterated goods or medicine knowingly	0.551
Component 3	Know about the punishable offence of selling and mixing unhealthy ingredient containing goods and food	0.476
Component 4	Know about the punishable offence of deceiving the consumers by false advertisement	0.491

Components of consumer rights protection awareness		Factor loading
Component 5	Know about the punishable offence of not selling or delivering goods or services properly as promised in consideration of money	0.565
Component 6	Know about the punishable offence of selling or delivering of goods less than offered weight	0.531
Component 7	Know about the punishable offence of showing more than actual weight by the weight measuring instruments	0.395
Component 8	Know about the punishable offence of selling or delivering less quantity of goods than the promised amount	0.509
Component 9	Know about the punishable offence of showing more than actual length by the length measuring gauge	0.513
Component 10	Know about the punishable offence of making or manufacturing any fake goods or medicine	0.483
Component 11	Know about the punishable offence of selling or offering to sell expired goods or medicine	0.531
Component 12	Know about the punishable offence of doing an act which may endanger life or security of the consumer	0.619
Component 13	Know about the Directorate of National Consumer Rights Protection	0.602
Component 14	Know about the CAB	0.574
Component 15	Desire to go for legal support	0.629

Component 3 and 4 have factor loadings close to 0.5. Component 7 shows a weak factor loading. All other twelve components exhibit factor loadings greater than 0.5. In total 53.791 percent of variance is explained where the variances of Component 1 and 2 together explain variance of 31.511 percent of the total variance.

As each of the items under consumer rights protection awareness have the value 1 for ‘yes’ and 2 for ‘no’, the Spearman’s correlation test is conducted to find out whether significantly each of the items is correlated to consumer rights protection awareness or not.

Table 3: Correlation between Consumer Rights Protection Awareness and the Items

Components of consumer rights protection awareness	Correlation coefficient
Know about the punishable offence of selling goods, medicine or service at higher price than fixed price	-0.527***
Know about the punishable offence of selling adulterated goods or medicine knowingly	-0.438***
Know about the punishable offence of selling and mixing unhealthy ingredient containing goods and food	-0.384***
Know about the punishable offence of deceiving the consumers by false advertisement	-0.466***
Know about the punishable offence of not selling or delivering goods or services properly as promised in consideration of money	-0.472***
Know about the punishable offence of selling or delivering of goods less than offered weight	-0.446***
Know about the punishable offence of showing more than actual weight by the weight measuring instruments	-0.422***
Know about the punishable offence of selling or delivering less quantity of goods than the promised amount	-0.447***
Know about the punishable offence of showing more than actual length by the length measuring gauge	-0.459***
Know about the punishable offence of making or manufacturing any fake goods or medicine	-0.356***
Know about the punishable offence of selling or offering to sell expired goods or medicine	-0.303***
Know about the punishable offence of doing an act which may endanger life or security of the consumer	-0.318***
Know about the Directorate of National Consumer Rights Protection	-0.335***
Know about the CAB	-0.374***
Desire to go for legal support	-0.259***

Note: *** represents significant at 1 percent level of significance.

The test shows that knowing about each of the items is significantly more likely to produce greater awareness level of consumer rights protection.

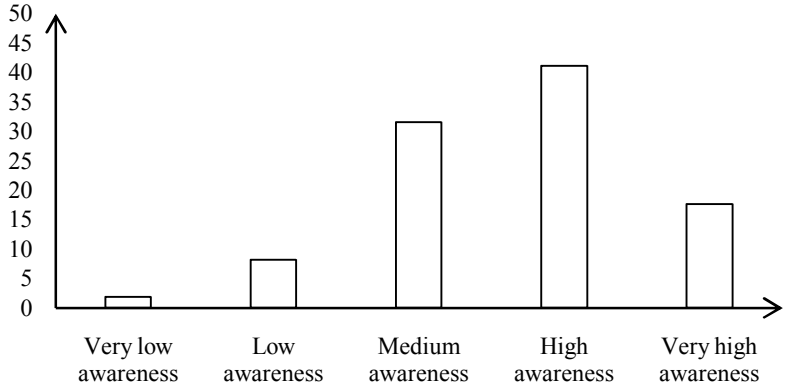
4. Result Analysis

4.1 Consumer Protection Awareness Level

40.99 percent of the respondents have high level of awareness of consumer rights protection. 31.530 percent, 17.57 percent, 8.108 percent,

and 1.802 percent of the people are aware in medium, very high, low, and very low levels respectively about their protection of rights as consumers.

Figure 1: Consumer Rights Protection Awareness Level



4.2 Gender and Consumption Expenditure Associations with Consumer Protection Awareness

In order to understand the gender and monthly consumption expenditure biasness on consumer rights protection awareness the Pearson Chi-Square test, likelihood ratio, and Cramer's V test are used as follows:

Table 4: Gender and Consumption Expenditure Associations with Consumer Protection Awareness

Variable	Pearson's Chi-Square	Likelihood ratio	Cramer's V
Gender	10.415**	10.677**	0.217**
Monthly consumption expenditure	27.114***	23.700**	0.202***

Note: ** represents significant at 5 percent level of significance.

Both the Chi-Square value and likelihood ratio, 10.415 and 10.677 respectively are statistically significant at 5 percent significance level, which makes a rejection of null hypothesis and indicates that consumer rights protection awareness is significantly influenced by gender. The Cramer's V value of 0.217 indicates that consumer rights protection awareness is significantly and moderately dependent on gender.

The Chi-Square value and likelihood ratio, 27.114 and 23.700 respectively are statistically significant at 1 percent and 5 percent significance levels respectively, which confirms that consumer rights protection awareness is significantly influenced by the differentiation in monthly consumption expenditure. The Cramer's V value of 0.202 indicates that consumer rights protection awareness is significantly and moderately biased on monthly consumption expenditure.

4.3 The Correlations between Gender and Awareness and between Consumption Expenditure and Awareness

In order to find out the correlations the Spearman's correlation and Kendall's Tau B are tested as follows:

Table 5: The Correlations between Gender and Consumer Protection Awareness and between Consumption Expenditure and Awareness

Variable	Spearman's Rho	Kendall's Tau B
Gender	-0.081	-0.075
Monthly consumption expenditure	0.137**	0.117**

Although Pearson's Chi-Square tells about the significant relationship between the gender and the consumer rights protection awareness, the Spearman's correlation and Kendall's Tau B tests do not represent any significant relationship between them, but the sign of the tests specifies that if a person is male, then he is more likely to be aware of protection rights.

The 0.137 and 0.117 ensure that there is a significant positive relationship between the monthly consumption expenditure and the consumer rights protection awareness level. It shows that if a person spends more for consumption, then he or she is significantly more likely to have high level of awareness although the strength of correlation is weak.

4.4 Individual Item Association

Pearson Chi-Square test is used to find out whether individual item under consumer rights protection awareness is dependent or independent on gender and monthly consumption expenditure as follows:

Table 6: Gender and Consumption Expenditure Associations with Individual Items

Items defining the consumer rights protection awareness	Gender	Monthly consumption expenditure
Know about the punishable offence of selling goods, medicine or service at higher price than fixed price	0.019	1.063
Know about the punishable offence of selling adulterated goods or medicine knowingly	0.594	12.186***
Know about the punishable offence of selling and mixing unhealthy ingredient containing goods and food	0.367	5.482
Know about the punishable offence of deceiving the consumers by false advertisement	0.155	6.386*
Know about the punishable offence of not selling or delivering of goods or services properly as promised in consideration of money	0.207	1.854
Know about the punishable offence of selling or delivering goods less than offered weight	6.582***	8.386**
Know about the punishable offence of showing more than actual weight by the weight measuring instruments	4.498**	7.231*
Know about the punishable offence of selling or delivering less quantity of goods than the promised amount	0.440	0.286
Know about the punishable offence of showing more than actual length by the length measuring gauge	0.000	3.586
Know about the punishable offence of making or manufacturing any fake goods or medicine	0.433	9.002**
Know about the punishable offence of selling or offering to sell expired goods or medicine	3.885**	10.168**
Know about the punishable offence of doing an act which may endanger life or security of the consumer	0.508	10.815**
Know about the Directorate of National Consumer Rights Protection	1.508	1.021
Know about the CAB	2.432	2.087
Desire to go for legal support	3.465*	0.536

Note: * represents significant at 10 percent level of significance.

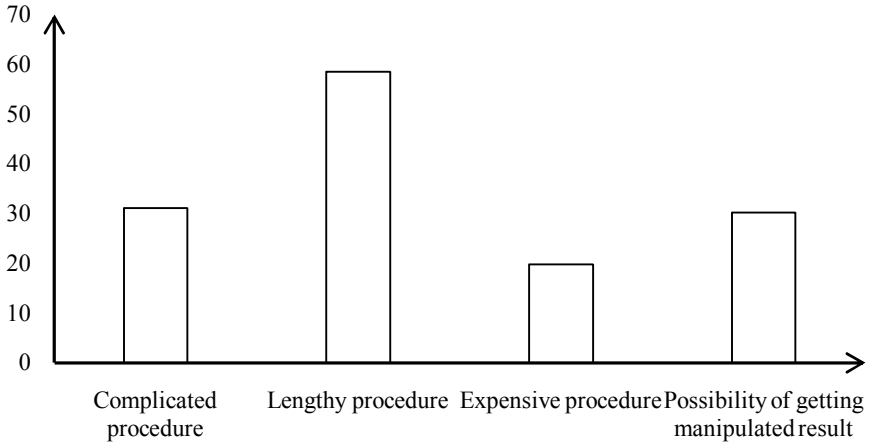
It shows that knowing about the punishable offences of selling adulterated goods or medicine knowingly, deceiving the consumers by false advertisement, selling or delivering goods less than offered weight, showing more than actual weight by the weight measuring instruments,

making or manufacturing any fake goods or medicine, selling or offering to sell expired goods or medicine, and doing an act which may endanger life or security of the consumer are all significantly monthly consumption expenditure biased. On the other hand, knowing about the punishable offences of selling or delivering of goods less than offered weight, showing more than actual weight by the weight measuring instruments, selling or offering to sell expired goods or medicine, desire to go for legal support are significantly gender biased.

4.5 Scenario of the Reasons of Not Taking the Legal Support

47.748 percent of the respondents do not want go for legal support in case of consumer rights violation. Among them 48.491 percent of respondents think that the procedure of taking legal support is lengthy and this is why they will not go for legal aid. 31.132 percent and 30.189 percent of the people believe that legal procedure is complicated and it provides a manipulated result respectively. 19.811 percent of total people treat legal procedure as expensive procedure.

Figure 2: Scenario of the Reasons of Not Taking the Legal Support



The study analyzes the reasons of avoidance of legal support with the aid of Spearman's correlation as follows:

Table 7: Reasons of the Avoidance of Legal Assistance and Their Correlations to Indicators

Indicator	Complicated procedure	Lengthy procedure	Expensive procedure	Manipulated result
Total awareness of consumer rights protection		-0.221**	-0.168*	
Gender			0.205**	
Monthly consumption expenditure			-0.251***	
Know about the punishable offence of selling and mixing unhealthy ingredient containing goods and food	0.218**			
Know about the punishable offence of doing an act which may endanger life or security of the consumer				-0.179*

The result shows that people who have high awareness of consumer rights protection are significantly more likely to avoid legal support because legal procedure is a lengthy procedure. If a person is male or his consumption expenditure is higher or his awareness is higher, then he is more likely and significantly treating the legal support as an expensive procedure. Those who do not know about the punishable offence of doing an act which may endanger life or security of the consumer have more possibility of not going for legal aid because it may represent manipulated result. Those who know about the punishable offence of selling and mixing unhealthy ingredient containing goods and food are significantly and more likely to believe that the legal assistance is complicated.

5. Conclusion

The study has found that the mean value of consumer rights protection awareness level is 3.644, which means that the level of consumer rights protection awareness is in between medium and high levels. The study shows that consumer rights protection awareness level is significantly dependent on both the gender and the consumption expenditure, specifically males are more likely aware than females and higher consumption expenditure undertakers are significantly more likely aware

of consumer rights protection awareness than low consumption expenditure undertakers. The research has also found that males are not taking legal support for the protection of their consumer rights because they believe that the legal procedure is costly and surprisingly people conducting higher consumption spending think that the legal assistance is expensive.

In order to increase the awareness of consumer rights protection level of female and low expenditure enjoying groups, the government or the other concerned organizations like CAB may conduct many projects and campaign programs. They can also take necessary policies which may help the males and high expenditure undertakers to believe that the legal support is necessary for consumer rights protection and it is inexpensive.

On this consumer rights protection awareness many researches can be conducted. If the study assumes 95 percent level of confidence and an error of 0.05, then with the standard deviation of 0.9944 that the study has found from the pilot study, the sample size becomes 1519. One can conduct this study. The sample size has been constructed only from Mirpur Thana in Dhaka city. One can select random sample from different areas. Only gender and consumption expenditure have been selected for the study whether other variables such as: age, education level, occupation type, size of the family and so on can be chosen for a new research. In the research Chi-Square test and Spearman's correlation tests have been used rigorously, where other researchers can use other statistical tests. The study has defined the consumer protection awareness level by the aid of Consumer Rights Protection Act 2009. So, one can conduct research by other Acts in relation to consumer rights protection available and applicable in Bangladesh.

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