



Different Methods of T Shirt Printing: A Comparative Analysis

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Abstract

The purpose of the study is to examine the different methods of T shirt printing. I have selected Kushtia zone for my data collection. Kushtia is an ancient city and it is very famous for cloth printing from the ancient time. T-shirt printing is one of the professions of the peoples in the Kushtia. Several procedures of printing such as dye sublimation, heat transfer and screen printing are engaged to print t-shirts in Bangladesh. However, screen printing is the most popular way in Bangladesh. It is easy to use and less costly. Despite the fact that the screen printing technique is the most ideal in Bangladesh, its developments come with challenges. The printing procedure is slow and the products that are churned out are of low quality. And in order to minimize the problems that local printers encounter during screen printing, the "Portable T-shirt Printing Machine" has been developed. The Portable T-shirt Printing Machine which is 80cm long, 50cm wide and 15cm high can be carried easily and printing can be done anywhere whether there is electricity or not. The adjustable metallic frame which holds the frame can be adjusted to suit any screen size; ranging from (45 cm by 45cm) to (16cm by 16m) or even smaller screens. The study design adopted for the qualitative (descriptive) approach. The sample population for the study is 110 representing 33% of the target population. The data collecting tools used were interview, observation and questionnaire. The main findings of the study were that, the speed of the traditional screen printing process can be improved when a machine is developed. Also, the fastness and competence of the t-shirt printing process have a direct relation with the income earned.

Keywords: Cloth printing methods, Screen Printing, T shirt, Portable, Kushtia.

1.0 Introduction

Aside from creating an excellent t-shirt design, the most important thing to consider is choosing printing technique. There are several techniques around and depending on their use, every one of them is effective in using for t-shirts. There are some benefits and cons to each of the printing techniques.

Screen Printing is the most common with the pros. Another name for this design is silkscreen printing. For this method to work, we will need a stencil, and a nylon mesh. We set up the stencil, which is held by the nylon mesh. A water proof material will block the negative space that we want to design. The negative space is the only part permeable for the dye. Ink is then flooded into the screen. The screen printing method is ideal for printing high-quality t-shirt designs, because it guarantees ultimate replication of the design. The screen printing methods gives a shirt a unique, cute and impressive look that customer love. Most companies that use the screen printing methods for mass production of t-shirt designs for our business. If we want a single or unique design for ourselves, it may be impossible. This method is suited for one color per screen. It is not ideal for super complex multi-color designs.

Direct to Garments (DTG) is like the screen printing method, it is also popular among hobbyists. It easy to do but it will require knowledge and skills if we are not going to get professional help. All we need for it work is the textile printer and ink. DTG works like a paper printer in the office. The only difference is that, in this case the ink is going to the fabric. We



first need to upload the design to the computer, which then creates uniqueness and creativity. The Direct to Garment method is excellent for printing out super-complex design. It gives a soft feel on the hands when we touch the final design. The ink used doesn't create thick extra layers on the shirt, because it is thin. However it has one problem. We can end up with a low resolution design with dot patterns if we have an inferior textile printer. We can't use this method to create design for dark fabric, because the ink is thin and won't look well. DTG is least durable and the fabric may fade in a year or less.

Dye sublimation works well on light shirts or fabrics. It cost to produce a dye sub but in the end, the customer ends up with a professional done shirt by experts. To bring out the best results in this method, we need to have deep knowledge in dye sublimation. Dye sublimation is perfect for printing polyester like cream fabrics. They are unforgiving when we bring cotton fabric to the scene. We will need a special type of dye which is liquid. The liquid dries up when it meets the polyester fabric. When it has dried well, it solidifies on the fabric, then we can apply heat and pressure for sublimation to take place. When the solid fabric is exposed to heat and pressure it turns into gas. The fabric molecules then expand and the gas sips between the gaps that appear in the cloth. In the end, the molecules contracts again when we remove the heat. Dye sublimation is excellent for printing polyester shirts with minimal enduring designs. Shirt done through sublimation are durable and looks cute.

Heat Press Printing is economical to use the heat press printing. It saves us resources and time. This method incorporates a design printed on a special paper called transfer paper. Here is how it works. We take a shirt, press it on the best heat transfer vinyl then apply heat and pressure. A more similar approach like the dye sublimation with slight differences. We do the process until the heat softens the dye on the paper until it gets a beneath the cloth. After that we take the glossy paper transfer and strip off the dye which leaves us with the intended design on the shirt. If we are working with super complex designs, then heat and press method is ideal for We. However, it won't work well with dark fabrics because of its translucent dye. Shirts printed through heat press printing are durable.

In Vinyl Cutting method a special soft clothing is cut into shapes or designs, then transferred to a shirt. Then these special designs are then placed onto the t-shirt using the heat press method. With this method, we can print one-off designs and even produce them in large numbers. It is the best alternative for printing multiple garment types. Vinyl cutting machine gives us the options of using different layers to print different colors of a design. Vinyl cutting is used in designing sportswear, slogan or small graphics. However, it suffers from one thing: They are letter-types parts that we can't use with it. T-shirt printed through vinyl cutting are durable.

Adu-Akwaboa (1989) defines screen printing as a process of transferring a good paper design onto a fabric. According to him, this is achieved by transferring the design onto a tracing paper (kodatrace) with opaque ink. Each color on the design must have a separate tracing paper. In other words, each color will have a separate screen for printing. A photographic method is used to transfer the design from the tracing paper to the screen with the help of light. During the photographic development of the screen, the opaque areas are left open for dye penetration while the negative areas are blocked to avoid dye penetration.

Tortora and Merkel (2005), explain the process of screen printing as a method of printing whereby the patterns are blocked out on a mesh fabric or screen so that when the color is



squeezed through, it will penetrate the unblocked areas. The color paste is forced through the screen by a squeegee. Each color in the pattern requires a separate screen.

Despite the easy accessibility of tools and materials for t-shirt printing, the processes involved in the printing are tedious. Two people are normally involved in the printing. One person holds the screen while the other pulls the squeegee to print the design. After printing, the squeegee is held in the hand for the next printing session but if care is not taken, the printing ink can spoil the hands which can easily be transferred onto the t-shirt thereby making it dirty. In the event where there is no person to assist the printer, printing becomes difficult and this can result in defects.

To mitigate the problems associated with T-shirt printing, the “Portable T-shirt Printing Machine” has been designed. It comes with a metallic frame which holds the screen, a detachable padded printing table and a free moving and adjustable squeegee. The “Portable T-shirt Printing Machine has the capacity to print a large number of t-shirts due to its fastness. It is portable and can be easily carried along and printed anywhere. The machine is convenient to print by one person. Thus, there is no need for a second person. The machine is therefore economical and less stressful.

2.0 Review of Related Literature

In order to strengthen the theoretical framework of this paper and to establish its uniqueness, frantic efforts have been made to review related literature from various sources such as the internet, books and monograms. The review was done under the following sub headings: Overview and process of Screen Printing, History of Screen Printing, T-shirt Printing and T-shirt Printing Machines.

2.1 Overview and process of Screen Printing

Basically, screen printing is the process of using a stencil to apply ink onto another material. A high tension polyester mesh (silk was used back in the day) is stretched over a frame and sections of it are blocked off creating a positive image where ink can pass through. Ink is pulled across the screen with a squeegee. Sometimes this is done with a very large automated press, sometimes by hand. All the printing at Kent Designs, garment and poster printing, is done by hand. Each color of the design needs to be printed one at a time with its own screen. Gradients and different opacities of color can be achieved with halftone patterns.

There are several steps that need to be completed sequentially in order for us to be able to easily print tee shirts. And in fact many different items may be printed with the standard tee shirt screen. The following is a step by step overview of how the process is done.

Artwork

This is the first and foremost task to accomplish on the agenda. Without art, we have nothing. It is also important to note that setting up art for screen printing is different than that of other types of printing. Art is critical. It needs to be set up properly for screen printing so that it may print easily and look great. We have to make sure that artwork is right before go to screen. It is wise to spend as much time as is needed to get it done correctly.

Choosing the Frame and Mesh

We can make a decent commercial grade screen ourselves with the appropriate equipment and/or tools as well as professional grade supplies or we can buy a screen premade with mesh



already stretched on it ready to go. Wood frames can be good if they are made well and sealed with lacquers. But wood frames age quickly and lose their rigidity especially when they are used and reclaimed on a regular basis. Metal screens work best if we plan on reusing the same screen for many different jobs as they need to be printed.

Prepping the Screen for Emulsion

Once we have chosen our frame and mesh and have our screen finished, we will be ready to prep the screen to coat with emulsion. This is a very simple step and only requires that we gently abrade the surface of the mesh with a mild abrasive while cleaning the mesh of any residual grease or dirt. This is normally done in a washout booth where the screen can be easily soaped up with "mesh prep" and thoroughly rinsed off. Now we would let them dry off completely in a dust free environment. This ensures that when the screen is dry it is clean enough to receive the emulsion without complications.

Coating the Screen with Emulsion

Now the screen is ready to coat with emulsion. Emulsion is a light sensitive liquid chemical that is applied to the screen; it becomes most light sensitive when dry. For this step the best tool is a scoop coater even if we are the home printer. This is a tool devised to be used by hand that resembles a trough the width of the screen with a rounded smooth edge or "blade" on one side. Typically a scoop coater for a 20 X 24 screen is about 14 inches wide so that we may coat a screen length wise with one pass from bottom to top. It will give us the most consistent, smooth coat and provide even thickness in the emulsion as well. The thickness of our stencil is directly related to the amount of ink that will be deposited onto the shirt. The thicker the emulsion is, the deeper the stencil is and more room the ink will have to be deposited onto the shirt. This gives better "opacity" or "coverage".

Placing Artwork on the Screen for Exposure

This should be done in subdued yellow or red light. For a one color design placing the film positive on the screen for exposure is quite simple. We will place it on the substrate side with the film facing up so that when we look at it from the ink well side the design will "read right". Just center the design from left to right and set it down about 3 or 4 inches from the top. The top would be the side that is closest to we when mounted in the press. Use clear Scotch Tape to hold the film in place on the emulsion coated screen. It is often helpful to make a "dog ear" on the tape for easy removal after being exposed and before washing out.

Exposing the Screen

Now that the art is taped to the screen in the appropriate place, we are ready to place it in the exposure unit and expose the emulsion to light. This is the step in which we cure the emulsion with light. Remember that our film positive will be 100% black for the areas that will print ink. The black areas on the film positive that make up our design will block the light from hitting and exposing the emulsion. Those unexposed areas of our design will remain water soluble while the rest of the emulsion on the screen, being exposed to light, will be cured and thus no longer water soluble. This means that the emulsion that was blocked from the light by our film positive will dissolve and wash out when rinsed with water.

Washing out The Stencil

Quickly take our screen to our washout booth and immediately wet both sides. Once the screen is wet it is relatively safe in regular light. Wet, uncured emulsion will be less reactive to light at this point. Gently rinse the screen on both sides with standard garden hose pressure from a



hand trigger spray nozzle. Be very gentle on the ink well side. This side is always slightly under cured and may look different in color and appear slimy or sudsy. This is normal. After gently rinsing both sides of the screen for about a minute or so turn the screen so that the substrate side faces us and let stand for a minute. Now focus on spraying the water directly at and through the image areas of our design.

Checking For Pinholes

Simply place the finished screen on a light table or hold it up against daylight and look for any unwanted holes or breaks in the emulsion due to dust or foreign debris. It is best to use a light table so that we may see what we are about to do. We will want to fill any pinholes or other mistakes with block out. Block out is an emulsion like chemical we can use to fill pinholes. It is not light sensitive and only needs to dry. Be sure it is compatible with our solvents and inks.

Post Cure

Many screen printers employ a technique known as the post cure. This is often done whether or not a photo emulsion was used as block out. In general, this is done to ensure that the ink well side of the screen is fully cured. The screen is simply put back on the exposure unit, this time with the ink well side facing down toward the light source, and exposed again. The top is pulled down but the vacuum is not necessary for this. We are just making sure all of the emulsion is fully cured and hard. Dual cure emulsions may not respond to post cures.

Taping Off the Screen for Printing

Tape off any areas on the sides of the emulsion toward the frame edge where there may be no emulsion present. Typically a scoop coater for a 20 X 24 screen is about 14 inches wide. This will leave about 2 inches or less of open mesh on the length sides near the frame edge. Make sure to tape off all 4 sides to ensure that stray ink will not pass through unwanted areas of open mesh. Some screen printers prefer to do this with block out. I find using masking tape or screen tape is best and costs less. We can tape off the edges of a screen on either side. It is our preference. I tape off my screens on the substrate side because I work in such a way with my ink that tape on the ink well side gets in my way. This is because I prefer to use the more controlled, efficient, and ergonomic pull flood and push stroke.

Going To Press

Now we are ready to go to press. We will assume that we are versed in the printing of a one color design; inking up the screen and flooding and stroking ink through the stencil onto the shirt with a squeegee. We will compare printing techniques later. For this part we will also need an understanding of how our particular press works. Get familiar with our press. Become friends with it. Name it, give it love for this machine we will be married to in a commercial business. The press can be our best friend and our worst enemy. Make sure our press is in good working order. Skimping on press maintenance and buying used equipment that is no longer in good shape is unwise. The better our press is, the easier it will be to print high quality prints quickly.

2.2 History of Screen Printing

Screen printing, screen printing, silkscreen printing, serigraphy are ways to identify an essential simple process with a long history in both art and industry. Along with its variety of names screen-printing is also a history of complexity in intent, technique and artistic use.



As a stencil process that blocks areas so another allows ink to pass through, screen printing is generally credited to China during the Song Dynasty (960-1279 CE). Other Asian countries, such as Japan, would further add innovation in combination with block printing and hand applied paints.

One advantage is that screen printing does not need a press, as in etching, inks can be adjusted for multiple surfaces from paper to ceramics and the application surface does not need to remain flat. Silkscreen printing refers to the original mesh used with a stencil; nylon, polyester and metal can replace the screen for the applied stencil. Whatever the choice of screen, it is most often affixed to a metal or wooden frame.

The Englishman Samuel Simon patented the screen printed form most familiar in the Western world in 1907. While Europe was introduced to the process in the 18th century, it would take the affordability of silk mesh and commercial use of the process to make it more available. Simon's use of his patented process was primarily used for printing expensive wall coverings on silk, linen, paper and other fine fabrics.

Early in 1910, along with photography, screen printers began experimenting with photo reactive chemical processes. Roy Beck, Charles Peters and Edward Owen are credited with the beginnings of a myriad of sensitizing processes still being refined by artists and industry. A group that formed the National Serigraphic Society first used "serigraphy" as a term to describe fine art created with this technique. This shift served to legitimize this technique in its two separate applications. The term came from the Latin "sericum" (silk) and the Greek "graphien" (draw or write). This distinction will lead to the development of the prominence known in the United States of "Pop Art" and the artist Andy Warhol.

Screen printing continues to adapt with the digital age with DTG (direct to garment) and DTS (direct to screen) and still accommodate the artist chosen inks and hand squeegeed artisan produced print runs.

With its adaptations to technology screen printing remains an innovative method for an artist to work with scale, color and surface. In the words of Andy Warhol, "It was all so simple, quick and chancy."

2.3 T-Shirt Printing

The printed t-shirt is so much a part of modern life that most people don't stop to consider its history. Printed t-shirts, however, did not just fall out of the sky; they came into existence through impressive technological innovations. The garment itself was originally intended to be a man's undergarment, to be worn under his military uniform or suit. Soldiers and sailors serving during WWII would frequently wear nothing but a shirt and their uniform trousers when off-duty or during especially hot or dirty work days. The t-shirt as a stand-alone garment gained popularity among civilians in the years following the war.

Textile printing has a much longer history than the t-shirt. The oldest and most time-consuming method of textile printing is woodblock printing. This dates to 3rd century China and relies on a relief design carved into a block of wood, which is then dipped into ink and pressed onto the fabric. Other less labor-intensive techniques were developed during the Renaissance and through the Industrial Revolution.



The era of custom t-shirts began in the early 1950s, when several companies in Miami, Florida started decorating t-shirts with the names of local resorts and other tourist attractions. Screen-printing - the most common method used for t-shirt printing - came into vogue about the same time. In 1959, a new stretchy ink made possible a wider variety of designs and lettering styles. Plastisol and water-based Inks would later become the dominant textile ink for screen-printing and coating.

Today, custom t-shirts are used as a method of personal expression through which individuals can express their political and social views, advocate for causes, or simply amuse onlookers. The printed t-shirt is also a nearly indispensable part of most large businesses' corporate marketing strategy, as t-shirts turn customers into "human billboards". Improvements in printing technology coupled with the ease and convenience of online ordering have put custom-made t-shirts within the reach of just about any business, organization, or club - no matter what its size or budget.

2.4 T-shirt Printing Machines

Epson F2000

With a roughly 3' by 5' foot print, the Epson F2000's foot print is similar to the GT-3 series from Brother — although at just over 1.5' high, it appears smaller at first look. This is a table or bench top design and is not free standing, so you'll need to plan on where it will be setup. Overall, the F2000 is a very quiet operating machine with a polished, put-together profile that works as easily in a home-based business as it does in a full production environment.

Brother GT-381

At 3.5' by 4.5,' the GT-3 series is a little boxier and immediately conveys an industrial look with its predominately metal exterior. The GT-381 is a table or benchtop unit but with a custom stand available. This stand is recommended, as it allows users to take advantage of the open bottom design of the printer for humidification, which is often necessary for consistent operation.

Col-Desi (DTG Digital) M2

Being the only dual platen printer of this group, the natural thought would be that it has a much larger foot print. At about 4' x 3,' it occupies a similar space but with a much larger shadow as it's nearly a complete rectangle. A tabletop/benchtop unit as well, the M2 will require proper arrangements. Quieter than the Brother GT-3 but not to the level of the Epson F2000, this unit can be an option for users that need an extra-large imaging area.

Kornit Breeze

As the introductory machine from Kornit, the Breeze is the smallest in their line-up but one of the largest in this group. The 4' x 5' framework is the most modern looking by far. As the only machine in the group with an integrated pre-treatment system, the overall foot print may be smaller. Kornit's inks are typically cured with a gas dryer which can serve as the base table for this printer.

M&R M-Link-X

As the only free-standing unit in this group, the M-Link X also has the distinction of being the largest at 4.5' x 5.5.' With a rugged steel frame and squared-off edging, the M-Link has the most industrial look and feel. Not the best option for home-based businesses, this unit is better suited for a production environment.



Intended Audience

In comparing these t-shirt printer models, it's best to start with their intended target audience. M&R and Kornit's focus has always been toward production shops while Epson, Brother and Col-Desi have tried to broaden their audiences to include smaller garment shops and even sign and graphics shops where t-shirts are often a complementary workflow.

2.5 Summary of Discussions

This stems from the fact that, screen printing is the most convenient and inexpensive method that can be used by anybody provided the person is given some form of training. The other methods: heat transfer, dye sublimation transfer and embossing are difficult to learn and expensive to produce. It is against this backdrop that the researchers of this paper thought it wise to base their work on screen printing machines. A critical review of the hand screen printing industry in Bangladesh reveals the difficulties that local screen printers face as a result of the use of crude tools and equipment. It has been observed that hand printing process is slow and full of deficiencies. To solve these teething problems, the "Portable T-shirt Printing Machine" has been invented. The next section of the paper will dell on the methodology.

3.0 Methodology

This part of the paper presents the various methods and procedures used in collecting and synthesizing data for the study. It is sub-divided into Research Design, Target Population, Sampling Techniques, Types of Data and Data Collection procedures.

3.1 Research Design

The research study was a descriptive one. This type of research portrays an accurate profile of persons, events or situations. The descriptive research therefore offers the opportunity to elaborate and tap the diverse views of respondents. (Amankwa *etal*, 2015). In this study, it was used substantively to describe the various processes involved in the manufacture of the "Portable T-shirt Printing Machine," from the design stage through to finishing stage.

3.2 Target Population

The Target Population for the study includes Way-Side Artists in the Kushtia Municipality, Visual Art students in selected SKS in Kushtia and its environs, Industrial Art students of Kushtia Technical Institute, Visual Art Tutors of selected SKS in Kushtia and its environs and Art Lecturers of Kushtia Technical Institute. The table below shows the numerical representation of the Target Population:

Table 1: Target Population

NUMBER	RESPONDENTS	POPULATION
1	Way-Side Artists	30
2	Visual Art students of selected SKS in Kushtia and environs	60
3	Industrial Art students of KTI	245
4	Visual Tutors	14
5	Art Lecturers	11
	Total	360

Source: Field Data, June 2017



3.3 Sampling Techniques

By the nature of this research, it was not possible to include all available population for study, therefore only the sample population was studied. The sample population includes selected Way-Side Artists in the Kushtia Municipality, selected Visual Art students of some selected SKS in Kushtia and its environs, selected Industrial Art students of Kushtia Technical University, selected Visual Art Tutors of some selected SKS in Kushtia and its environs and some selected Art Lecturers in Kushtia Technical University. The Sample Population represents 30% of the Target Population (360) which gives a sample size of (108) respondents as shown in table 2 below:

Table 2: Sample Population

NUMBER	RESPONDENTS	POPULATION
1	Way-Side Artists	9
2	Visual Art students of selected SKS in Kushtia and environs	20
3	Industrial Art students of KTI	73
4	Visual Tutors	5
5	Art Lecturers	3
	Total	110

Source: Field Data 2017

3.4 Types of Data

Two forms of data were collected for the study. These were: primary and secondary data. Primary data relevant to the study were collected from the field by the help of research tools. The research tools used for the study were: observation, interview and questionnaire. Secondary data were collected from books, publications, catalogues, periodicals, newsletters, brochures, journals, magazines, monograms, charts.

3.5 Data Collection Procedures

For a study like this, the use of the following research instruments: observation, interview and questionnaire was indispensable. They all played vital roles in eliciting valid data for the study.

3.5.1 Observation

The natural way of gathering information is by observation and it is most direct in terms of studying people when one is interested in the explicit behavior and the result achieved or obtained is real and precise through mechanical and electronic means (Sidhu, 1984). By the nature of this study, the observational approach was very helpful in capturing the exact appearance of objects related to the study. It was used extensively to record the hand screen process and the state of printing machines in Kushtia and its environs. The researchers thus visited the Art Centres in the Kushtia Municipality and critically observed the screen printing process which forms the basis for this research.

3.5.2 Interview

Interview which is more or less an oral questionnaire was used to obtain vital information from a section of the Sample Population. It was observed by the researchers that about 12% of the Sample Population could neither read nor write. Therefore in order not to side line any of the respondents, the interview approach was used. The use of interview also afforded the researchers the opportunity to seek the clarification of the same information in several ways at various stages of the interview, thus providing a check of the truthfulness of responses. An



interview guide was prepared and administered to the interviewees at prior notice. It was observed that certain confidential information which could not be divulged by respondents when employing the other research tools were willingly given out; as the researchers took time to explain the questions more clearly to the interviewees just the way they wanted it.

3.5.3 Questionnaire

A questionnaire is a written or printed form of questions used in gathering information on some subject or subjects consisting of a list of questions to be submitted to one or more persons. (Agra *et al*, 2015). The researchers therefore used this research instrument to elicit written information from the Sample Population. 108 questionnaire copies were administered to the Sample Population made up of 9 Way-side Artists, 20 Visual Art students from selected SKS in Kushtia and its environs, 73 Industrial Art students of KTI, 5 Visual Art Tutors and 3 Art Lecturers. The questions bothered on the understanding of screen printing, t-shirt printing, uses of t-shirts, available screen printing machines and their efficiency.

3.6 Summary of Discussions

This section of the paper succeeded in presenting the various research methods adopted in collecting and synthesizing data for the study. It touched on the target population, data collecting procedures and sampling techniques adopted by the researchers. The next section will dwell on the data analysis and working procedures.

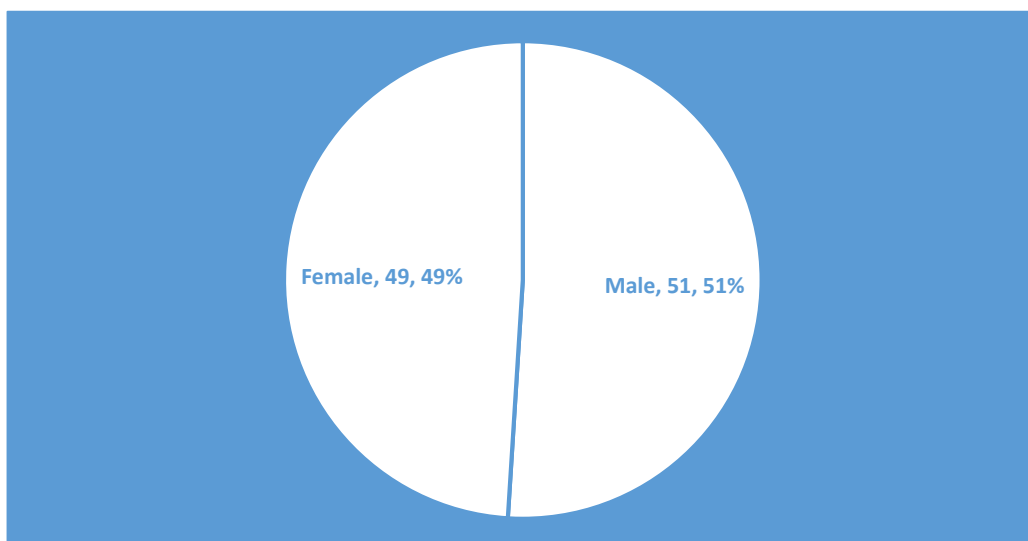
4.0 Analysis and Interpretation of Data

This part of the paper presents the statistical analysis of primary data for the study. The study made use of pie charts, bar charts and tables to analyze data.

4.1 Demographic Characteristics of Respondents

The pie chart below displays the gender distribution of respondents. According to the chart, 51% the respondents are male while 49% are female. This points clearly to the fact that the gender orientation of the study area is evenly distributed.

Chart 1: Gender Distribution



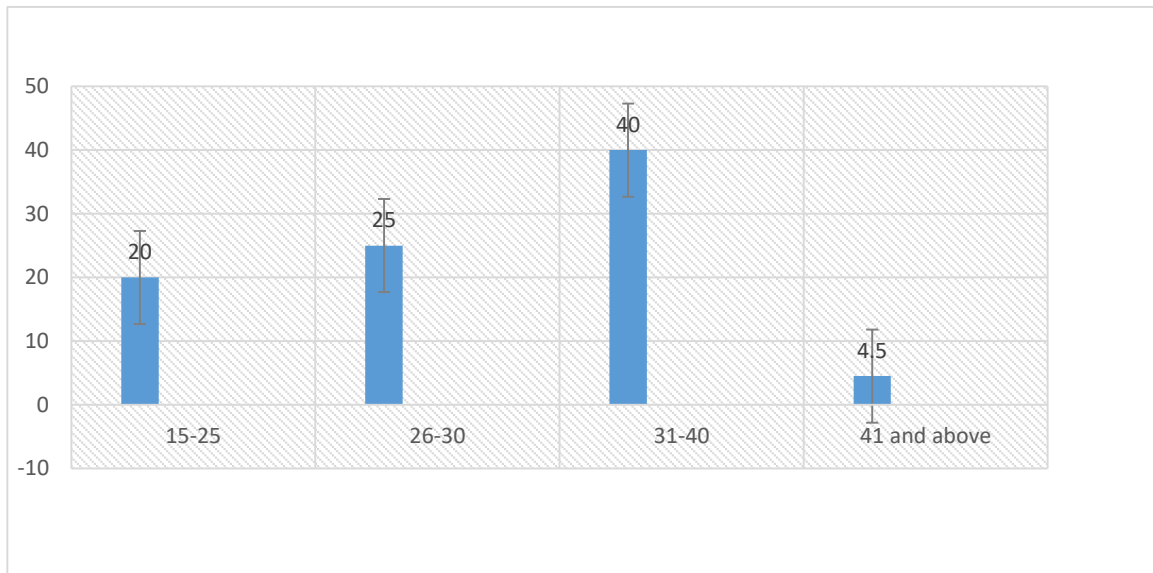
Source: Field Data, June 2017



4.2 Age Distribution of Respondents

The chart below shows the age distribution of respondents. It is clear from the chart that majority of respondents (40%) fall within the age bracket of 31- 40 years. This suggests the maximum involvement of the middle-aged Weth in the study. Furthermore, 25% of respondents who participated in the study fall within the age bracket of 26-30. Also, 20% of the respondents are within the age bracket of 15-25.

Chart 2: Age Distribution

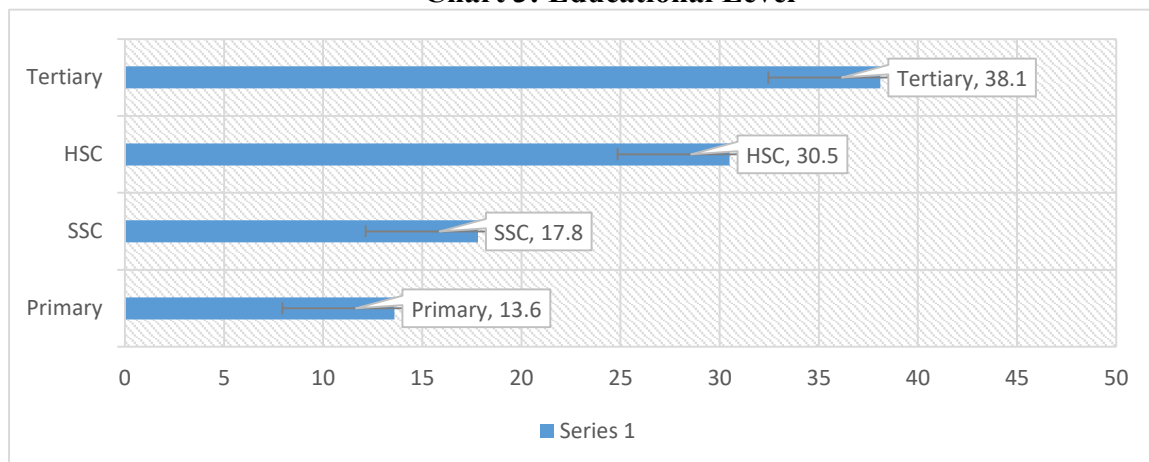


Source: Field Data, June 2017

4.3 Level of Education of Respondents

Chart 3 below displays the Educational Level of respondents who participated in the study. The results are skewed in a descending order. Majority of the respondents (38.1%) had tertiary education. This is followed by 30.5% of the respondents who attended HSC. As many as 17.80% of the respondents were SSC leavers while 13.6% of the respondents attended primary school.

Chart 3: Educational Level



Source: Field Data, June 2017



4.4 Assessing Respondents' knowledge about Screen Printing

In table 3 below, the researchers sought to assess the knowledge of respondents on screen printing. The results are as follows: a whopping sum of 107 respondents representing 99.9% of the sample population gave a response in the affirmative while 1 respondent representing a negligible percentage of 0.1 gave "No" as an answer. It is obvious from the results that majority of the respondents chosen for this study have knowledge on the topic under discussion.

Table 3: Yes or No responses to the question: "do you have any knowledge about Screen Printing?"

Table with 3 columns: Responses, Frequency, Percentage (%). Rows: Yes (107, 99.9), No (3, 0.1), Total (110, 100).

Source: Field Data, June 2017

4.5 Responses to the assertion: "Screen Printing is one of the methods of printing t-shirts"

Table 4 below presents the test results obtained from respondents concerning the statement that screen printing is one of the methods of printing t-shirts. 80 respondents representing 74.1% of the sample population agreed to the assertion while 3 respondents representing 2.8% of the sample population disagreed with the assertion. Furthermore, 25 respondents representing 23.1% of the sample population strongly agreed to the assertion.

Table 4: Responses to the statement: "Screen Printing is one of the methods of printing t-shirts"

Table with 3 columns: Responses, Frequency, Percentage (%). Rows: Strongly disagree (0, 0.0), Disagree (3, 2.8), Neutral (0, 0.0), Agree (82, 74.1), Strongly agree (25, 23.1), Total (110, 100).

Source: Field Data, June 2017

4.6 Responses to the statement: Manual Printing is bedeviled with problems

It is clear in table 5 below that almost all the respondents (98.15%) strongly agree that manual printing is bedeviled from problems. however, 2 of the respondents representing 1.85% of the sample population were neutral.

Table 5: Responses to the statement: Manual Printing is bedeviled with problems

Table with 3 columns: Responses, Frequency, Percentage (%). Rows: Strongly disagree (0, 0.0), Disagree (0, 0.0), Neutral (2, 1.85), Agree (0, 0.0), Strongly agree (108, 98.15), Total (110, 100).

Source: Field Data, June 2017



4.7 Assessing the knowledge of respondents on the efficiency of Hand Screen Printing

Table 6 and 7 below display the responses of respondents on the efficiency of Hand Screen printing process. Table 6 collates the results of respondents on the speed of the Hand Screen printing Process while table 7 collates results on the assertion that the Hand Screen printing process is slow. In table 6, a good number of respondents (26) representing 24.07% of the sample population were neutral. They could neither agree to the assertion that: Hand Screen printing is fast nor slow. Interestingly, as many as 73 of the respondents representing 67.59% of the sample population disagreed with the assertion while a negligible number of 9 respondents representing 8.34% of the sample population agreed to the assertion. In table 7 below, 11 respondents representing 10.2% of the sample population disagreed with the assertion that Hand Screen printing is slow while as many as 78 respondents representing 72.3% of the sample population agreed to the assertion. Additionally, 19 respondents representing 17.58% of the sample population strongly agreed to the assertion. Based on the responses given in table 6 and 7 below, a logical conclusion can be drawn that there is the need to do something to increase the speed of Hand Screen printing.

Table 6: Responses to the assertion: "Hand Screen Printing is fast"

Table with 3 columns: Responses, Frequency, Percentage (%). Rows include Strongly disagree, Disagree, Neutral, Agree, Strongly agree, and Total.

Source: Field Data, June 2017

Table 7: Responses to the assertion: "Hand Screen Printing is slow"

Table with 3 columns: Responses, Frequency, Percentage (%). Rows include Strongly disagree, Disagree, Neutral, Agree, Strongly agree, and Total.

Source: Field Data, June 2017

4.8 Relating the fastness of the t-shirt printing process to increased income

Table 8 below presents the test results of respondents on the assertion, "the fastness of t-shirt printing is directly linked to increased income. The results are as follows: a good number of the respondents (37) representing 34.26% of the sample population were neutral while 45 respondents representing 41.67% of the sample population agreed to the assertion. Furthermore, 12 respondents representing 11.11% of the sample population strongly agreed to the assertion. However, 14 respondents representing 12.96 % disagreed with the assertion.



Table 8: Responses to the assertion: “the fastness of the t-shirt printing process is directly linked to increased income”

Responses	Frequency	Percentage (%)
Strongly disagree	0	0.0
Disagree	14	12.96
Neutral	39	34.26
Agree	45	41.67
Strongly agree	12	11.11
Total	110	100

Source: Field Data, June 2017

4.9 Exploring the defects associated with Hand Screen Printing

The table below displays some of the defects of manual printing outlined by respondents. Majority of the respondents (31) representing 28.70% of the sample population mentioned overlapping as one of the defects while 28 respondents representing 25.93% of the sample population stated bleeding as one of the defects. Additionally, 24 respondents representing 22.22% of the sample population stated that the screen dries quickly due to slow printing. Furthermore, 15 respondents representing 13.89% of the sample population were of the view that shifts and gaps occur in manual screen printing. 10 respondents representing 9.26 % of the sample population mentioned blurred edges as one of the defects that occur in manual screen printing.

Table 9: some defects associated with Manual Screen Printing

Responses	Frequency	Percentage (%)
Bleeding of designs	28	25.93
Blurred edges	10	9.26
Overlapping of designs	33	28.70
Shifts and gaps in designs	15	13.89
Drying of screen due to slow printing process	24	22.22
Total	110	100

Source: Field Data, June 2017

4.10 Addressing the defects of Manual Screen printing

Table 10 below presents the responses of respondents on how to address the defects of Manual Screen printing. 46 respondents representing 42.59% of the sample population stated that in order to address the defects of Manual Screen printing, an automated device should be manufactured. Furthermore, 23 respondents representing 21.29% of the sample population intimated that enough and even pressure should be exerted on the screen during printing to prevent bleeding and patchy printing. Additionally, a good number of respondents (19) representing 17.59% of the sample opined that good screen development would avert the defects of manual screen printing while 13 respondents representing 12.04% of the sample population stated that when the appropriate tools and materials are used, the defects of Manual Screen printing will be avoided. Last but not the least, 7 respondents representing 6.49 of the sample population were of the view that more hands should be engaged during screen printing.



Table 10: addressing the defects of Manual Screen Printing

Responses	Frequency	Percentage (%)
Manufacture of an automated device	46	42.59
Good development of screens	19	17.59
Limiting pressure exerted on screen during printing	25	21.29
Using the appropriate tools and materials	13	12.04
Employing more hands during printing	7	6.49
Total	110	100

Source: Field Data, June 2017

5.1 Production Processes

In order to address the problems associated with t-shirt printing using the traditional approach, the researchers designed and manufactured the “Portable T-shirt Printing Machine.” The machine which was made from metal pipes and metal plates has the following features: an adjustable squeegee, leather padded table, an adjustable metallic frame which holds the screen during printing and a magnetic holder which holds the frame taut during printing without the help of a second person. The squeegee can be moved manually by the help of a bearing and a hollow pipe. The squeegee blade which is made of rubber can easily be removed and washed after each printing session. The “Portable T-shirt Printing Machine” which is 75cm long, 45cm wide and 12cm high can be carried easily and printing can be done anywhere, whether there is electricity or not. The adjustable metallic frame which holds the frame can be adjusted to suit any screen size; ranging from (40 cm by 40cm) to (15cm by 15m) or even smaller screens. The printing is less stressful as there is no need to set up a fresh printing table and additional hands are not needed.

5.2 Tools and Materials

The following tools and materials were used to produce the machine: welding machine, file, grinding machine, electrode, hacksaw, tape measure, vice, g-clamp, pencil and eraser, angle pipes, hollow pipes, bolts and nuts, galvanize metal plate, foam, leather, plywood, hinges, magnetic locker, iron rod, two holders, rubber blade, auto base paint, lacquer, spraying machine, porti filler and hardener and sand paper.

5.2.1 Production

- i. After developing various ideas from existing machines, the production processes started. First, the base frame was formed using the hollow pipes. The pipes were cut to the required dimensions by the help of a hacksaw and then welded using the welding machine.
- ii. Plate 2: welding of the base frame
- iii. Secondly, the angle pipes were welded to the base frame to serve as a rail through which the squeegee will move by the help of a bearing.
- iv. This was followed by welding the frame holders to the top frame as illustrated below. The frame holders are made up of two angle bars and adjusters. The adjusters which are made up of bolts and nuts make it possible for the holders to be adjusted to suite the required frame size (between 40cm and 15cm).



- v. At this stage of the construction process, the top frame and base frame were joined together using hinges as shown below. This enables the two frames to open and close when the need arises. A pair of small shock bars was later attached to both the top and base frames to enable the top frame stand still when it is opened for fixing of the screen. The shock bars also play an important role in preventing any accidents that may occur as a result of the top frame falling off.
- vi. This was followed by fixing the squeegee frame into the rail in readiness for fixing the squeegee. Two bearings were fixed to the sides of the squeegee frame to facilitate the movement of the squeegee when it is propelled. The squeegee frame is made up of two flat metal plates connected with an angle pipe and iron rod at the middle section. The iron rod has been fixed there purposely to give stability to the squeegee frame.
- vii. The next stage was to fix the squeegee in the squeegee frame as shown in plate 7 below. The squeegee is made up of a metallic handle and a rubber blade. The rubber blade can be easily removed and cleaned after each printing session. The squeegee handle can accommodate wider or smaller blades depending on the size of the screen being used. The squeegee can be detached from the squeegee frame for replacement during printing or for maintenance.

5.2.2 Finishing

Finally, the machine was given a finishing treatment by first grinding the welded parts to smoothen them. Porti filler was then applied at rough edges and welded parts and then polished by sand-papering. This was followed by priming of the metal surfaces with grey paint. After that, blue auto-base paint was sprayed evenly to cover all metal parts except the handle of the squeegee which was sprayed with gray color. After the paint had dried, a thin film of lacquer was then applied to enhance the beauty and sheen of the machine. In addition, two frame handles were fixed to the top frame to make lifting easy. Two magnetic lockers were also fixed to the base frame to ensure the firm contact of the screen with the printing table without any human assistance. The leather padded printing table was finally, fixed into the base frame as illustrated in plate 8 below. The padded table can be easily detached from the machine for cleaning or easy transport of the machine from one place to another.

5.2.3 Testing of Machine

After production, the machine was tested by printing one color on a t-shirt. It was observed that the design came out well and was devoid of any “bleedings”. The squeegee was also able to move with ease and printing was done once as compared to the traditional printing where the squeegee is moved several times before a design is printed. Quite apart from these, it was observed that the magnetic locker was able to hold the screen firmly on the t-shirt and this made it possible for only one person to do the printing. This will invariably contribute to the cut down on production cost. However, it is believed that when the machine is automated, the speed will increase and that will contribute to a higher production rate and more income.

6.0 Summary of Findings, Conclusion and Recommendations

6.1 Findings

The following main findings of the study have been itemized:

- The speed of Manual Screen printing can be enhanced by developing a machine.
- The Traditional Screen printing technique is bedeviled with challenges.



T-shirts are important in the social life of a people. There is a high demand for t-shirts in Bangladesh.

The fastness and efficiency of the t-shirt printing process have a direct relation with the income earned.

The Portable T-Shirt printing machine prints with fewer errors.

The machine has relatively high speed as compared to Traditional Screen printing.

The Portable T-shirt printing machine can be printed by only one person without any assistance.

6.2 Conclusion

These machines have the capacity to print several yards of fabric a day because of their high speed. Their printing quality is also very good. However, in the Hand Screen printing industry in Bangladesh, crude methods of printing are employed. Some local printers improvise plywood and bathroom slippers as squeegee for printing. As a result, poor quality designs are produced which attract only few customers and this affects the revenue that is generated from the sale of such works. With the introduction of the "Portable T-shirt Printing Machine," it is hoped that the speed and quality of printing will be enhanced greatly.

6.3 Recommendations

Maintenance Requirements – it's not difficult, but we do have to maintain our Portable T-shirt Printing Machine by running 15-30 minutes worth of cleanings every day. On some Portable T-shirt Printing Machine this is simple, on others, like the Espon F2000, it's expensive because of the amount of ink that's wasted during cleaning.

Storage – Not nearly as bad as screen printing, but you will need to find adequate air conditioned storage for your bottles of ink. Each bottle can be up to \$300 for a liter of white ink or as little as \$150 for smaller ones or cartridges, so no spilling!

Learning Curve – probably about the same as screen printing. Most new custom t shirt businesspeople aren't graphic artists and have to learn how different art affects the output onto the shirt. Also, learning maintenance, shirt types, etc. is going to be vital.

Limitations – Portable T-shirt Printing Machine are designed to print on cotton and other untreated natural fibers. That means no polyester, no sportswear, and no promotional items like cups, koozies, umbrellas, poly bags, etc.

The following recommendations have given based on the findings. It is hoped that the recommendations will be implemented to the latter.

The machine must be maintained regularly.

The printing table and squeegee must be removed and cleaned with soap and water after each printing session.

The machine must be oiled regularly to prevent friction and corrosion of the metal parts.

Future researchers should use a step-up motor to automate the printing mechanism so as to increase the speed of printing.

The local printers must adopt the "Portable T-shirt Printing Machine" to ameliorate their printing process.



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