Sudan University of Science & Technology

College of Postgraduate Studies

EVALUATION OF WASTE IN PRODUCTION IN KARARRI PRINTING, PUBLISHING, AND DISTRIBUTION COMPANY

تقييم الفاقد في الانتاج في شركة كرري للطباعة والنشر والتوزيع

A thesis submitted in partial fulfillment of the requirement for the degree of M.Sc. in mechanical engineering (production)

Prepared by:

BILAL AHMED SAEED ALI

Supervisor:

Dr. YASIN MOHAMMED HAMDAN

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كلية الدراسات العليا

بسم الله الرحمن الرحيم

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Name of Candidate: Bilal | Ahmed | Saeed | Ali

Thesis title: Evaluation of Waste in Production in HARARI Printing, Publishing, and Distribution Company

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Approved by:

1. External Examiner

Name: M. I. Shukri (Professor)

Signature: ..... Date: 27/4/2019

2. Internal Examiner

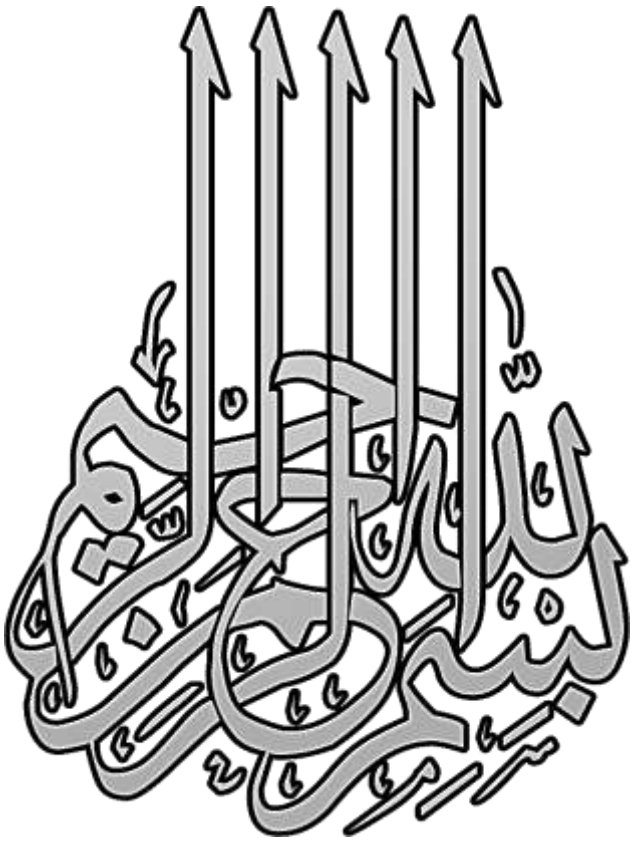
Name: Gafer Abd Alhamid

Signature: ..... Date: 27/4/2019

3. Supervisor

Name: Yasin Mohamed Hamdan

Signature: ..... Date: 27/4/2019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يقول الله تعالى :

﴿ فَفَهَّمْنَاهَا سُلَيْمَانَ وَكُلًّا آتَيْنَا حُكْمًا وَعِلْمًا وَسَخَّرْنَا مَعَ دَاوُودَ الْجِبَالَ يُسَبِّحْنَ وَالطَّيْرَ وَكُنَّا فَاعِلِينَ (٧٩) وَعَلَّمْنَاهُ صَنْعَةَ لَبُوسٍ لَكُمْ لِتُحْصِنَكُمْ مِنْ بَأْسِكُمْ فَهَلْ أَنْتُمْ شَاكِرُونَ (٨٠) ﴾

صدق الله العظيم

القرآن الكريم ، الجزء السابع عشر ، سورة الأنبياء ، الآيتان (79–80)

DEDICATION

To Soul of my parent in their heaven , to my family , my brother , my sisters , my wife and my kids.

Also this work dedication to all my friends in kararri company , also to big family Sudan.

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Firstly I would like to than Dr. Yasin Mohammed Hamdan for the valuable guidance he has provided to to complete this thesis. many thanks to my friend Eng. Mohammed Elabbas doka and Eng. Mohammed abdelwahid ,Iwould like to thank all people in Mechanical Engineering department in Sudan university of science and technology.

ABSTRACT

This research deals with the assessment of the loss of printing in the company of Karri Printing and Publishing, which serves primarily the publications of the armed forces in addition to meet some of the needs of the local market of printing.

This research focuses on the waste in paper because it represents the highest cost of all production inputs. Therefore, 30 samples of four different products have been studied: non-colored books, semi-colored books, full color books and finally magazines.

The losses were calculated in each sample and the loss was transferred to a financial value. The study showed that the highest losses were in paper and specifically in magazines, then full color books, then semi-colored books and finally non-colored books.

المستخلص

يتناول هذا البحث تقييم الفاقد في الطباعة في شركة كرري للطباعة والنشر ،وهي شركة تخدم في المقام الاول مطبوعات القوات المسلحة اضافة الي تلبية بعض احتياجات السوق المحلية من الطبوعات .

يركز هذا البحث علي الفاقد في الورق لانه يمثل التكلفة الاعلي من بين جميع مدخلات الانتاج ، لذلك فقد تمت الدراسة علي اخذ (30) عينة من اربعة منتجات مختلفة وهي كتب غير الملونة والكتب شبه الملون والكتب الملونة كاملا واخيرا المجلات.

تم حساب الفاقد في كل عينة وتحويل الفاقد لقيمة مالية، واتضح من خلال الدراسة ان الفاقد الاعلي كان في المجلات ثم الكتب الملونة كاملا ثم الكتب شبه الملونة واخيرا الكتب غير الملونة .

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Chapter one

INTRODUCTION

1 Chapter one: INTRODUCTION

1.1 PREFACE

The printing press industry is one of the gigantic industries in the world, it is developed day by day following the high growth in technology. To stay relevant in this industry companies must keep growing up, and seeking continuous development.

The kararri printing, publishing, and distribution company, is a pioneer printing company in Sudan. It serves all printing required by the Sudan Army primarily, and also the local market. In order to preserve this market cost reduction must be made.

This research focuses on evaluating the waste experienced by the company and resulted in limiting the company's competition in the local market due to high cost of scrap which contributes to the cost of the product.

1.2 PROBLEM STATEMENT

The printing press contributes to a large amount of production inputs waste, which contributes to the cost of product being made, yet no clear evaluation of the seriousness of the problem has been made.

1.3 AIM OF PROJECT

The aim of this thesis is to understand the current paper waste situation at a kararri printing publishing and distribution company, investigate its causes and suggest an approach for how paper waste can be reduced at the company. The research strategy of this thesis combines both qualitative and quantitative methods including observations, interviews, production data analysis, and production measurements.

1.4 OBGECTIVES OF THESIS

- Identify the areas where paper waste is generated.
- Analyze the waste in terms of monetary value to product cost.

- Propose a solution to reduce or stop the waste.

1.5 METHOD

The method of this thesis combines both qualitative and quantitative methods which include observations, production data analysis, and production measurements.

Chapter Two

THERORETICAL BACKGROUND

2 THERORETICAL BACKGROUND

2.1 PRINTING PROCESS

Offset printing is a commonly used printing technique in which the inked image is transferred (or "offset") from a plate to a rubber blanket, then to the printing surface. When used in combination with the lithographic process, which is based on the repulsion of oil and water, the offset technique employs a flat (planographic) image carrier on which the image to be printed obtains ink from ink rollers, while the non-printing area attracts a water-based film (called "fountain solution"), keeping the non-printing areas ink-free. The modern "web" process feeds a large reel of paper through a large press machine in several parts, typically for several metres, which then prints continuously as the paper is fed through.

Development of the offset press came in two versions: in 1875 by Robert Barclay of England for printing on tin, and in 1904 by Ira Washington Rubel of the United States for printing on paper.In offset printing the matter to be printed is neither raised above the surface of the printing plate (as in letterpress) nor sunk below it (as in intaglio, or gravure, printing). Instead, it is flush with the surface of the plate; thus offset is classified as a planographic method of printing.(Adam Augustyn,2005)

Offset printing, as a development of lithography, is based on the principle that water and grease do not mix, so that a greasy ink can be deposited on grease-treated printing areas of the plate, while nonprinting areas, which hold water, reject the ink. The offset plate is usually of zinc or aluminum or a combination of metals, with the surface treated to render it porous and then coated with a photosensitive material. Exposure to an image hardens the coating on printing areas; the coating on nonprinting areas is washed away, leaving wetted metal that will reject ink.

Modern offset printing is done on a press composed basically of three rotating cylinders: a plate cylinder, to which the metal plate is fastened; a blanket cylinder covered by a sheet of rubber; and an impression cylinder that presses the paper into contact with the blanket cylinder. The plate cylinder first comes in contact with a series of moistening rollers that deposit moisture in the granulations of the metal. A series of inking rollers then pass over the plate, and the ink is rejected by the water-holding areas

and accepted by the greasy image. The inked image is transferred to the rubber blanket and is then offset to the paper travelling around the impression cylinder. (Brittanica encyclopedia,2005)

Lithography was initially created to be an inexpensive method of reproducing artwork. This printing process was limited to use on flat, porous surfaces because the printing plates were produced from limestone. In fact, the word "lithograph" historically means "an image from stone" or "printed from stone". Tin cans were popular packaging materials in the 19th century, but transfer technologies were required before the lithographic process could be used to print on the tin.

The first rotary offset lithographic printing press was created in England and patented in 1875 by Robert Barclay. This development combined mid-19th century transfer printing technologies and Richard March Hoe's 1843 rotary printing press—a press that used a metal cylinder instead of a flat stone. The offset cylinder was covered with specially treated cardboard that transferred the printed image from the stone to the surface of the metal. Later, the cardboard covering of the offset cylinder was changed to rubber, which is still the most commonly used material.

As the 19th century closed and photography became popular, many lithographic firms went out of business. Photoengraving, a process that used halftone technology instead of illustration, became the primary aesthetic of the era. Many printers, including Ira Washington Rubel of New Jersey, were using the low-cost lithograph process to produce copies of photographs and books. Rubel discovered in 1901—by forgetting to load a sheet—that when printing from the rubber roller, instead of the metal, the printed page was clearer and sharper. After further refinement, the Potter Press printing Company in New York produced a press in 1903. By 1907 the Rubel offset press was in use in San Francisco.

2.1.1 Modern offset printing

One of the important functions in the printing process is prepress production. This stage makes sure that all files are correctly processed in preparation for printing. This includes converting to the proper CMYK color model, finalizing the files, and creating plates for each color of the job to be run on the press.

Offset lithography is one of the most common ways of creating printed materials. A few of its common applications include: newspapers, magazines, brochures, stationery, and books. Compared to other printing methods, offset printing is best suited for economically producing large volumes of high quality prints in a manner that requires little maintenance. Many modern offset presses use computer-to-plate systems as opposed to the older computer-to-film work flows, which further increases their quality.

Advantages of offset printing compared to other printing methods include:

- consistent high image quality. Offset printing produces sharp and clean images and type more easily than, for example, letterpress printing; this is because the rubber blanket conforms to the texture of the printing surface;
- quick and easy production of printing plates;
- longer printing plate life than on direct litho presses because there is no direct contact between the plate and the printing surface. Properly developed plates used with optimized inks and fountain solution may achieve run lengths of more than a million impressions;
- cost. Offset printing is the cheapest method for producing high quality prints in commercial printing quantities;
- ability to adjust the amount of ink on the fountain roller with screw keys. Most commonly, a metal blade controls the amount of ink transferred from the ink trough to the fountain roller. By adjusting the screws, the operator alters the gap between the blade and the fountain roller, increasing or decreasing the amount of ink applied to the roller in certain areas. This consequently modifies the density of the colour in the respective area of the image. On older machines one adjusts the screws manually, but on modern machines the screw keys are operated electronically by the printer controlling the machine, enabling a much more precise result.

Disadvantages of offset printing compared to other printing methods include:

- slightly inferior image quality compared to rotogravure or photogravure printing;

- propensity for anodized aluminum printing plates to become sensitive (due to chemical oxidation) and print in non-image–background areas when developed plates are not cared for properly;
- time and cost associated with producing plates and printing press setup. As a result, very small quantity printing jobs may now use digital offset machines.

Every printing technology has its own identifying marks, as does offset printing. In text reproduction, the type edges are sharp and have clear outlines. The paper surrounding the ink dots is usually unprinted. The halftone dots can be hexagonal though there are different screening methods.(Brittanica encyclopedia,2005)

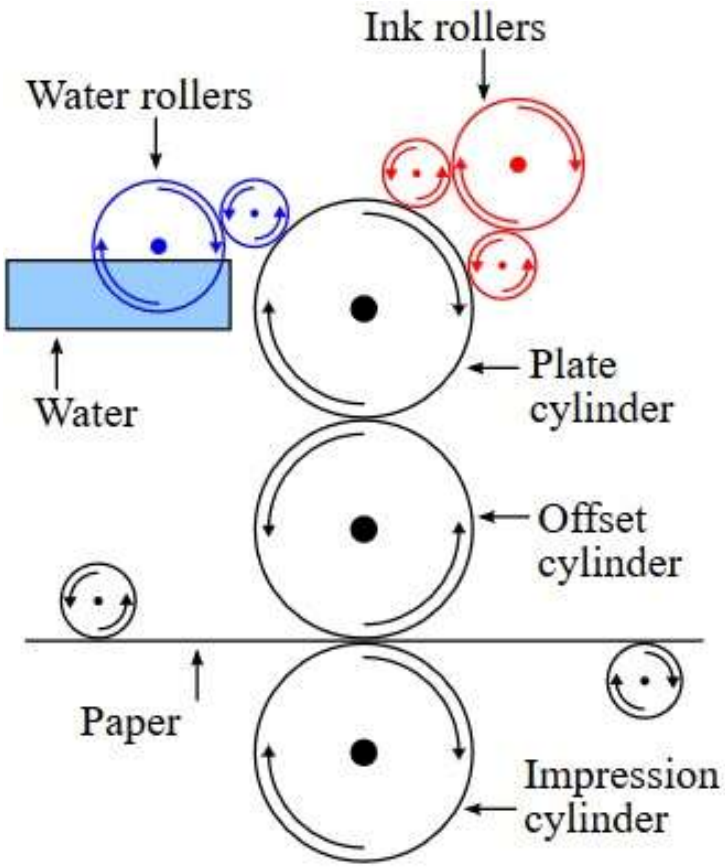


Figure 1 offset printing

2.2 PAPER USED IN PRINTING

Printing presses uses a large range of papers, the types of paper and their sizes and weight are elaborated below:

2.2.1 Bond paper

This type of paper is stronger and more durable than the average sheet of paper. Instead of being made from low grade wood pulp, it is mostly made up of rag pulp. It's perfect for letterheads, typed reports and envelopes.

2.2.2 Gloss coated paper

Gloss paper is typically used for flyers and brochures as it has a high shine. As the ink dries well there is no need for a seal varnish as the ink does not rub off.

2.2.3 Matt coated paper

Matt paper is the opposite to gloss – it is coated with a matt finish to produce a paper that isn't shiny, preventing glare. This type of paper is perfect for reports, flyers and leaflets.

2.2.4 Recycled paper

Made from re-used paper products, recycled paper is perfect for those who are trying to reduce their environmental impact. It can be used for most documents including reports, memo paper and forms.

2.2.5 Silk coated paper

The interim between gloss and matt, silk coated paper has a smooth silky coating, leaving it smooth to the touch but without the shine of glass paper. This type of paper can be used for many things such as magazines, books and catalogues.

2.2.6 Uncoated paper

Typically found in most office printers, uncoated paper has no coating, making it excellent for ink receptivity and absorbency. As it is uncoated it has the advantage of being used by both printer and pen, ideal for forms, letterheads and memo paper.

2.2.7 Watermarked paper

Used in high quality paper watermarked paper give a feel of luxury and high quality. To create its desired effect an impression is pressed into the paper by attaching a wire pattern. This type of paper is commonly used as a security feature for important documents, including exam certificates.

2.2.8 Paper size and weight

Paper Weight Descriptions

Weight	Feels Similar to:
35-55 gsm	Most newspapers
90 gsm	Mid-market magazine inner pages
130-250 gsm	A good quality promotional poster
180-250 gsm	Mid-market magazine cover
350 gsm	Most reasonable quality business cards

Figure 2 paper weight

Table of Paper Sizes from A0 to A10

Size	Width x Height (mm)	Width x Height (in)
A0	841 x 1189 mm	33.1 x 46.8 in
A1	594 x 841 mm	23.4 x 33.1 in
A2	420 x 594 mm	16.5 x 23.4 in
A3	297 x 420 mm	11.7 x 16.5 in
A4	210 x 297 mm	8.3 x 11.7 in
A5	148 x 210 mm	5.8 x 8.3 in
A6	105 x 148 mm	4.1 5.8 in
A7	74 x 105 mm	2.9 x 4.1 in
A8	52 x 74 mm	2.0 x 2.9 in
A9	37 x 52 mm	1.5 x 2.0 in
A10	26 x 37 mm	1.0 x 1.5 in

Figure 3 Paper sizes

2.3 OFFSET PRINTING INKS

Offset printing inks are compounded especially for use on offset presses. They must be able to withstand reaction with the press fountain solution it encounters on the dampened offset plate. Ideally, the ink on the ink roller should not absorb water (water-in-ink emulsification), nor should the ink break down and combine with the fountain solution on the non-printing areas of the plate (ink-in-water emulsification). Either of these emulsification problems will tend to impair the body, color, or drying qualities of the ink, or cause tinting on the non-printing areas of the plate and printed sheets.

The offset printing inks used on an offset printing press must be able to carry the full-intended color and covering power to the paper despite the split-film action. This occurs because the offset blanket picks up only a portion of the ink from the plate and delivers only a portion of that to the paper. The film of ink reaching the plate, then, is very thin, and the ink must be able to show its full color and opacity with this film.

2.3.1 Offset printing ink composition

Ink is made of three main ingredients: Pigment, which is the coloring material in the ink; Vehicle, which is the liquid that holds the particles of pigment; and Modifiers, which control the drying of the ink as well as other factors such as smell, scuff resistance, and fading.

PIGMENT: There are two basic types of pigment used in offset printing inks.

Organic pigment, which is made from carbon, is used for making black ink. Inorganic pigments, which are made by mixing various chemicals together, are used for colored inks. For example, sulfur, silica, or china clay can be combined with either soda ash or sulfate salts to make ultramarine blue ink.

VEHICLE: Vehicle is the liquid that holds the particles of pigment and carries them to the paper. There are two kinds of vehicles used in offset inks: oils such as soya oil or linseed oil (which is a yellowish oil made from flax); and synthetic vehicles, which are

liquids resulting from the mixture of chemicals. For example, phenol and formaldehyde mixed together make phenolic resins, sometimes used in printing inks as a vehicle.

MODIFIERS: Modifiers are ingredients added to the ink to control drying and other qualities such as smell and resistance to fading.

Figure 4 ink used in offset printing

2.4 GENERAL PAPER WASTE GENERATION

In the past few decades, considerable social and economic changes have been taking generation place, which have had a profound effect on consumption. Higher living standards in the western world and the desire to catch up on the part of the developing world have led to an increase in the consumption of consumer goods. With increased economic prosperity and consumption, a considerable amount of waste is being generated, not only in the products we consume, but also from the paper materials . This, together with the increase in international trade and the trend towards urbanisation has created longer distances between producers and consumers and therefore a greater demand for appropriate packaging.

Other contributing factors include changes in lifestyles and social changes – increases in the number of working families, i.e. where both spouses go to work, along with the increase in microwaves and freezers,

smaller family units1 and single person households. (Pira international, 2007).

2.5 CLASSIFICATION OF WASTE

It is important to note that waste do differ from process to process and the methods of reducing waste in one printing process do not necessarily apply to other printing processes. There are three major waste streams found in the printing industry. They include:

(a) solid waste – in general printing environment solid waste could consist of empty containers, used film packages, outdated materials, damaged plates, developed films, dated materials, test production, bad printing or spoilage, damaged product, and scrap papers.

(b) water waste – water waste from printing operations may contain lubricating oils, waste ink, clean-up solvents, photographic chemicals, acids, alkaline, and plate coatings, as well as metals such as silver, iron, chromium, copper, and barium .

(c) air emissions – printing operations produce volatile organic compound emissions from the use of cleaning solvents and inks, as well as alcohol and other wetting agents used in lithographic printing. Larger plants can be the source of sulfur dioxide emissions (Lewis, 1982). Finishing operations may include final trimming, die cutting, folding, collating, binding, laminating,

embossing, and assembling operations. Binding methods include stitching (stapling), gluing, and mechanical binding. The primary waste are binding and laminating chemicals and scrap papers (Banerjee, 2001).

2.6 WASTE AND THE ENVIRONMENT

An awareness of environmental, health, and safety issues plays an important role in the identification of printing technologies. Lithographic printers may not be familiar with available government-supported environmental information programs, and may rely primarily on vendors, suppliers, customers and trade association for such information (Rothenberg, Toribio, and Becker, 2002). Printing operations use materials

that may adversely affect air, water, and land resources: certain chemicals involved in printing volatilize, which contributes to air emissions from the facility and to smog formation; other chemicals may be discharged to drains and impact freshwater or marine ecosystem; and solid waste contribute to the existing local and regional disposal problems.

There is a growing concern about industrial waste and pollution, health and safety hazards to industrial workers, public health problems due to adverse environmental changes and the misapplication of hazardous chemicals. Atmospheric pollution associated with industrialization activities result mainly from combustion processes. These pollutants tend to be in the form of particulate matter, smog, odor, and nuisance gases. These emissions contain varying amounts of gases such as nitrogen, hydrocarbons, and carbon. Apart from the health problems caused by these gases, they also contribute to the problem of acid rain. In recent years, hydrocarbons have been identified as substances contributing to the global ozone depletion problem (Tilley, 1999). In the printing industry inks such as web offset heatset and non-heat set inks contain hydrocarbons in their formulation. The improper disposal of fixer, for instance, can be very harmful to the environment. The disposal of fixer is a big problem for the environment (Appiah, 2002).

Figure 5 waste and environment

2.7 TYPES OF WASTE

waste in general can be categorized into two:

Waste Type I: non value-adding, but necessary for end-customers. These are usually harder to eliminate because while classified as non-value adding, they may still be necessary. For example, while an end-customer might not view quality inspection in car assembly as value-adding, it is necessary to ensure the car meets safety standards.

Waste Type II: non value-adding and unnecessary for end-customers. These contribute to waste, incur hidden costs, and should be eliminated.

2.8 WASTE MANAGEMENT

Waste management is an umbrella expression incorporating all activities needed to manage waste, from conception to final disposal. Waste management activities can include, as previously mentioned, the collection, transportation, treatment and disposal of waste, as well as monitoring and regulating the production process to prevent waste generation and to support reuse and recycling (OECD, 2003). Waste management methods vary significantly across organizations, countries, regions and sectors (Davidson, 2013), as individual waste management methods are not capable of handling all types of waste in a sustainable way (Davidson, 2013; McDougall et al., 2008).

When exploring different waste management methods the waste management hierarchy can be used as a guide since it classifies waste management options according to their desirability (Nilson et al., 2007). The hierarchy indicates a preferred order of action to reduce and manage waste in terms of their environmental impact and sustainability (Davidson, 2013). Different versions of the waste management hierarchy exist, but all share fundamental characteristics and convey the same essence (Davidson, 2013; UNEP, 2013; El-Haggar, 2007).

In 2008 the European Union (EU) adopted a five-step version of the waste management hierarchy acting as the cornerstone of the Waste Framework Directive. The directive guides waste legislation and policy within all member states in the EU, and requires member states to adopt

national waste management plans and waste prevention programs based on the hierarchy (EU, 2008). (Lundberg, Wallin 2016)

In terms of ink used in printing press, the most effective way to save costs is to reduce the amount of ink waste coming from the processes. The following practices are used to reduce ink waste, saving raw materials and waste costs:(Davis 2001)

- Optimize press scheduling to minimize color changes. Efficient scheduling can greatly reduce press downtime and labor associated with press cleaning, which increases solvent use, ink losses, and shop towel use. Use a standard ink sequence— from light to dark to minimize degree of cleaning needed between ink changes. Group print jobs and production runs according to the colors needed. Consider the ink lay-down sequence on multi-color presses.
- Practice proper ink handling methods. Encourage operators to keep ink containers closed unless adding or removing ink from the can. Prior to closing the can, coat the lip of the can with petroleum jelly or a similar ink-compatible product to form an air-tight seal on the can. This will prevent oxidation and drying, and make the lid easy to remove.
- Track ink usage. Keep accurate records of the quantity of ink used for specific jobs, particularly repeat jobs. Train press operators in ink-estimating techniques to help them accurately estimate the amount needed for each job. Establish ink inventory controls. Monitor ink inventory and use existing stock according to the "first-in/first-out" strategy. Test any out-of-date ink for usability before considering it a waste ink. Carefully label, log, and store special order colors for future use rather than dumping them into waste ink drums.

2.9 RESEARCH METHOD FOR IDENTIFYING PRINTING WASTE IN GHANA

A researcher has tackled a similar issue concerning waste in printing presses in Ghana. Being an African country with limited resources and similar environment, which has the same conditions found in karray printing press in Sudan, it was important to review the way in which the study method was conducted giving admirable results, the method included the following :

2.9.1 Sampling

In the researcher's attempt to conduct an effective study, a population which was made up of all printing houses In Accra and Kumasi was considered. The sample size was made up of forty-seven (47) printing houses. The sample frame was chosen with the random sampling method with each printing house having not less than five employees. There are about 92 registered printing houses in Accra and Kumasi. Out of the 55 questionnaires distributed, an impressive number of 47 were retrieved. The responses were compiled, analyzed, and presented on tables. Comparisons and deductions were made and implications were drawn from the responses (Chea 2008)

2.9.2 Data analysis

Spoilage/wastage in a printing house cannot be done eliminated, but can readily be controlled. There are many causes of spoilage/wastage in a printing house. The data gathered will help find out from the printing houses selected, the causes of spoilage/wastage in the presses; their ways of disposal; the effects of spoilage/waste on a company and the environment. This section groups the data collected into three sub headings. These include (1) grouping the printing houses in the sample (2) causes of paper spoilage/wastage and (3) causes of film and darkroom chemicals wastage/spoilage.

The questions used in collecting the data are stated and the responses are presented in tables. Deductions, inferences, explanations, and implications are then used to analyze the responses

2.9.3 Causes of Paper Wastage/Spoilage: Machines

The working condition of the machines in the printing house is as vital as the expertise of the machine operator. All the parts of the machine are supposed to work properly if quality of work is to be achieved. The feeder board, grippers, cylinders, rollers, delivery board etc., must be in place and functioning properly to avoid the malfunctioning or the total break-down of the machines during production. This calls for the regular maintenance of the machines to keep them in good condition which will help in the reduction of waste in the printing house. In view of this, the researcher asked the following question: Do you have a maintenance schedule for your

machines? The answer options to the question were Yes and No. 89% of the respondents have a maintenance schedule program. 11% do not have a maintenance schedule program. It could also be that, even though they do not have a schedule for maintaining their machines, they may have their own way of ensuring that their machines are in good condition for work. In a bid to know if the maintenance schedule was implemented by the printing houses under study, the researcher asked accordingly. From the data, 9% hada weekly maintenance schedule program, 42% had a monthly maintenance schedule program, 28% carry out a yearly maintenance schedule program, and 21% did not choose any of the options but had their own reasons such as (a) the machines are checked daily and will therefore not need a total maintenance section (b) the machines are not faulty and so if they are tempered within the verge of maintenance, they may develop problems and (c) they may even break down totally due to the constant removing of screws and bolts. When machines break down due to poor maintenance, production time is wasted. And when apart of the machine is faulty, papers and other materials are wasted.

2.9.4 Materials with high rate of spoilage

The researcher wanted to find out the most wasted material in the press. The data reveal that paper records the highest percentage of spoilage/waste. Some respondents specified that newsprint is most wasted. Ink is considered to be the second most wasted material according to 11% of the respondents. Films, darkroom chemicals, and plates made up 8% of the respondents. The fact cannot be disputed that paper is the most wasted material in the printing house

2.9.5 Paper storage

Printing houses normally buy their papers in bulk and keep them in storerooms for production. Papers must be stored in a proper storeroom. That is, a well-ventilated room with cabinets, good roofs without leakage, and good windows and doors. If paper is not well-stored, it can create a lot of problems for the printer. (Dimensional problems such as humidity, crumpling of the paper, and color change of paper are some examples). With paper, proper storage will avoid damage from temperature, humidity, and spills as well as physical

damage. On this note, the researcher's focus was to know if printers encounter difficulties printing with stored papers. The responses gathered revealed that 32% encounter some difficulties when printing with stored papers, but 62% do not encounter difficulties in printing with stored papers. 6% did not choose any option. The 62% of the respondents that do not encounter problems when printing is quite encouraging. This is because if difficulties are not encountered, then waste is avoided. 32% of the respondents encounter difficulties when using stored papers because their papers are not properly stored.

Chapter Three

METHODOLOHY

3 METHODOLOHY

3.1 DATA COLLECTION METHOD

To identify the area where the majority of paper waste is located, three steps were taken to accomplish this task.

- Observation
- Waste calculation
- Data analysis

3.1.1 Observation

A total of 30 batches of different products (black ink books, semi color books, full color books and magazines) were observed during printing. The observation started once paper was available and the printing order was given. To compare the data it was sought that books should be around 288 pages (average number of pages is 288).

The type of paper that has been used is the 70*100 sheet where 1 sheet is equivalent of 16 A4 papers in booth books and magazines. This step has been taken so that when comparison is done it the samples would be similar.

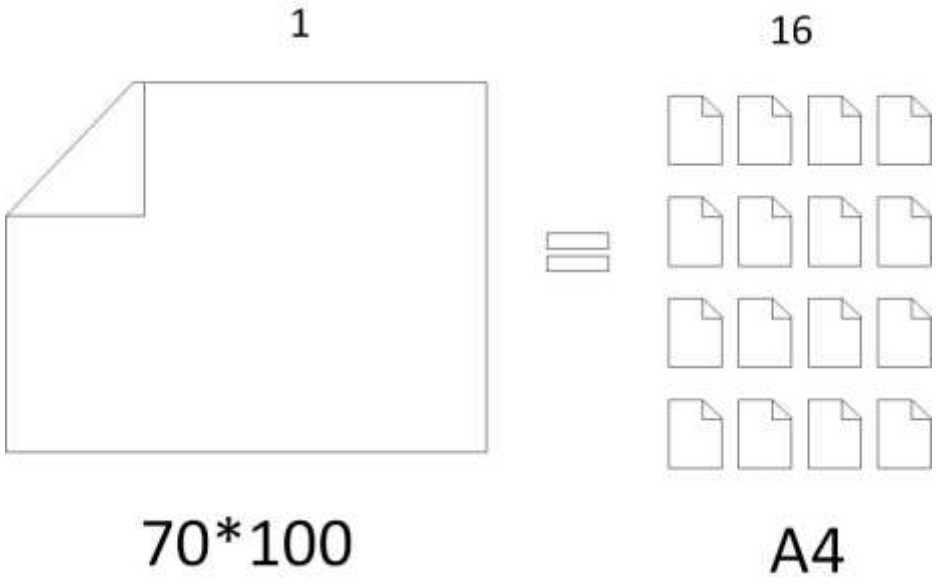


Figure 6 Paper size = 70 X 100

3.1.2 Waste collection

The manner in which waste has been collected is by calculating the number of papers that will not be part of the final product due to any circumstance (machine setup, uneven colors, torn paper, cutting to fit required book size, mistake by operator…etc.).

In the first step of setting up the complete paper (size 70*100) would be wasted so it was easily calculated by the number of papers. In the case of folding the paper was also calculated per paper as the incorrect folding would mean the entire paper is scraped. The difficult part was the to calculate the waste in the final cut after stapling to get the book in the correct dimension. The solution was to measure the mass of a single (70*100) paper and calculate the overall mass of the small strips of paper and then see how much (70*100) papers the strips are equivalent to.

3.1.3 Data analysis

To make sense of the data collected, the number of scraps was divided into three categories (printing, folding and stapling and cutting). The total percentage for each batch was calculated.

Batch number	Batch size	Phase one: printing	Phase two: folding & stapling	phase three: cutting	Total scrap rate	number of scrap books	total number of pages (average)	total cost of scrap paper in SDG (average)
							144	0.23

Table 1 books data tables header

Batch number		Number of printed batches	
Batch size		The number of books per batch	
Phase one: printing		Percentage of scrap due to printing (quantity of scarp in books /batch size)	
Phase two: folding & stapling		Percentage of scrap due to folding and stapling (quantity of scarp in books /batch size)	
phase three: cutting		Percentage of scrap due to cutting (quantity of scarp in books /batch size)	
Total scrap rate		The sum of all scrap rates	
number of scrap books		Scrap rate*batch size	
total number of pages (average)	144	The total number of scrap papers per book per total batch	Number of average pages= 288 Number of papers = 288/2= **144** (each paper has two pages)
total cost of scrap paper in SDG (average)	0.23	Total cost of scrap paper per book per batch in Sudanese pounds	One single paper (70*100) = 3.68 SDG 1 paper (70*100) = 16A4 papers Cost of 1 paper of A4= 3.68/16 = **0.23**

Table 2 explanation of books tables header

Batch number	Batch size	Phase one: printing	Phase two: folding & stapling	phase three: cutting	Total scrap rate	number of scrap books	total number of pages (average)	total cost of scrap paper in SDG (average)
							72	0.3

Table 3 magazine data table header

Batch number		Number of printed batches	
Batch size		The number of books per batch	
Phase one: printing		Percentage of scrap due to printing (quantity of scarp in books /batch size)	
Phase two: folding & stapling		Percentage of scrap due to folding and stapling (quantity of scarp in books /batch size)	
phase three: cutting		Percentage of scrap due to cutting (quantity of scarp in books /batch size)	
Total scrap rate		The sum of all scrap rates	
number of scrap books		Scrap rate*batch size	
total number of pages (average)	72	The total number of scrap papers per book per total batch	Number of average pages= 144 Number of papers = 144/2= **72** (each paper has two pages)
total cost of scrap paper in SDG (average)	0.3	Total cost of scrap paper per book per batch in Sudanese pounds	One single paper (70*100) = 4.8 SDG 1 paper (70*100) = 16A4 papers Cost of 1 paper of A4= 4.8/16 = **0.3**

Table 4 explanation of magazines data table header

3.2 COLLECTED DATA

	Process scrap rate				
Batch number	Batch size	Phase one: printing	Phase two: folding & stapling	phase three: cutting	Total scrap rate
1	500	4.20%	0.015%	0.010%	4.225%
2	1000	3.10%	0.023%	0.012%	3.135%
3	620	4.00%	0.030%	0.014%	4.044%
4	900	3.40%	0.000%	0.013%	3.413%
5	350	4.60%	0.015%	0.012%	4.627%
6	320	4.80%	0.180%	0.014%	4.994%
7	450	4.40%	0.024%	0.018%	4.442%
8	1500	2.80%	0.035%	0.012%	2.847%
9	500	5.00%	0.030%	0.016%	5.046%
10	510	4.20%	0.075%	0.015%	4.290%
11	600	3.80%	0.045%	0.015%	3.860%
12	520	3.80%	0.015%	0.024%	3.839%
13	530	4.40%	0.015%	0.024%	4.439%
14	500	4.80%	0.005%	0.023%	4.828%
15	600	3.90%	0.018%	0.010%	3.928%
16	620	3.60%	0.090%	0.015%	3.705%
17	2600	2.20%	0.075%	0.014%	2.289%
18	450	5.20%	0.030%	0.017%	5.247%
19	3000	1.80%	0.015%	0.012%	1.827%
20	560	3.70%	0.090%	0.017%	3.807%
21	700	3.60%	0.060%	0.018%	3.678%
22	700	3.80%	0.090%	0.019%	3.909%
23	650	4.60%	0.030%	0.019%	4.649%
24	320	5.60%	0.015%	0.016%	5.631%
25	440	4.40%	0.023%	0.016%	4.439%
26	350	5.20%	0.015%	0.016%	5.231%
27	560	4.80%	0.105%	0.016%	4.921%
28	3000	1.90%	0.030%	0.023%	1.953%
29	1000	2.60%	0.015%	0.016%	2.631%
30	850	3.40%	0.030%	0.012%	3.442%

Table 5 Books - Black color printing data

	Process scrap rate				
Batch number	Batch size	Phase one: printing	Phase two: folding & stapling	phase three: cutting	Total scrap rate
1	700	5.40%	0.045%	0.012%	5.457%
2	500	5.85%	0.068%	0.016%	5.934%
3	1000	3.00%	0.072%	0.014%	3.086%
4	800	3.60%	0.056%	0.012%	3.668%
5	450	6.60%	0.045%	0.012%	6.657%
6	750	4.50%	0.113%	0.019%	4.632%
7	600	4.80%	0.041%	0.016%	4.857%
8	550	6.60%	0.052%	0.012%	6.664%
9	2000	3.00%	0.113%	0.015%	3.128%
10	750	5.70%	0.090%	0.014%	5.804%
11	3000	2.85%	0.050%	0.018%	2.918%
12	550	5.70%	0.052%	0.017%	5.769%
13	750	5.70%	0.072%	0.019%	5.791%
14	850	6.30%	0.029%	0.018%	6.347%
15	1500	3.00%	0.113%	0.013%	3.126%
16	660	6.00%	0.113%	0.019%	6.132%
17	950	5.70%	0.027%	0.020%	5.747%
18	800	4.80%	0.050%	0.014%	4.864%
19	600	6.00%	0.047%	0.017%	6.064%
20	940	6.90%	0.158%	0.015%	7.073%
21	700	8.40%	0.090%	0.016%	8.506%
22	550	8.70%	0.068%	0.012%	8.780%
23	660	7.50%	0.180%	0.013%	7.693%
24	560	7.80%	0.203%	0.013%	8.016%
25	3000	3.30%	0.158%	0.015%	3.473%
26	900	6.00%	0.045%	0.013%	6.058%
27	700	4.80%	0.025%	0.019%	4.844%
28	2500	3.00%	0.090%	0.016%	3.106%
29	500	7.80%	0.027%	0.018%	7.845%
30	800	6.30%	0.090%	0.017%	6.407%

Table 6 Books- Semi color printing data

	Process scrap rate				
Batch number	Batch size	Phase one: printing	Phase two: folding & stapling	phase three: cutting	Total scrap rate
1	700	7.60%	0.036%	0.018%	7.654%
2	550	9.20%	0.150%	0.016%	9.366%
3	900	6.00%	0.090%	0.015%	6.105%
4	1000	5.60%	0.120%	0.020%	5.740%
5	2000	4.40%	0.180%	0.017%	4.597%
6	600	7.80%	0.170%	0.018%	7.988%
7	450	8.80%	0.036%	0.019%	8.855%
8	880	7.40%	0.042%	0.017%	7.459%
9	850	6.80%	0.066%	0.016%	6.882%
10	650	8.00%	0.105%	0.016%	8.121%
11	700	7.20%	0.042%	0.014%	7.256%
12	900	6.40%	0.054%	0.018%	6.472%
13	2000	3.60%	0.162%	0.015%	3.777%
14	500	7.92%	0.063%	0.017%	8.000%
15	800	5.60%	0.069%	0.017%	5.686%
16	600	8.40%	0.105%	0.015%	8.520%
17	3000	3.20%	0.153%	0.014%	3.367%
18	500	8.40%	0.042%	0.018%	8.460%
19	800	7.60%	0.057%	0.016%	7.673%
20	900	5.80%	0.084%	0.015%	5.899%
21	400	11.36%	0.129%	0.014%	11.503%
22	700	7.20%	0.075%	0.018%	7.293%
23	600	8.40%	0.102%	0.015%	8.517%
24	950	6.16%	0.108%	0.017%	6.285%
25	770	6.40%	0.036%	0.017%	6.453%
26	600	7.56%	0.042%	0.019%	7.621%
27	800	4.92%	0.075%	0.014%	5.009%
28	3000	3.00%	0.102%	0.012%	3.114%
29	500	10.56%	0.048%	0.025%	10.633%
30	900	7.12%	0.072%	0.019%	7.211%

Table 7 Books - full color printing data

	Process scrap rate				
Batch number	Batch size	Phase one: printing	Phase two: folding & stapling	phase three: cutting	Total scrap rate
1	1100	19.60%	0.126%	0.012%	19.74%
2	1500	18.30%	0.171%	0.014%	18.49%
3	1500	14.40%	0.189%	0.011%	14.60%
4	1550	14.40%	0.120%	0.012%	14.53%
5	750	22.80%	0.126%	0.016%	22.94%
6	1250	19.00%	0.275%	0.012%	19.29%
7	900	18.80%	0.133%	0.010%	18.94%
8	1900	19.20%	0.165%	0.011%	19.38%
9	2300	16.40%	0.250%	0.012%	16.66%
10	1100	20.20%	0.282%	0.014%	20.50%
11	3500	13.70%	0.345%	0.019%	14.06%
12	1000	19.40%	0.135%	0.011%	19.55%
13	1200	20.48%	0.165%	0.011%	20.66%
14	1250	22.48%	0.085%	0.011%	22.58%
15	2000	14.08%	0.230%	0.012%	14.32%
16	1500	19.48%	0.338%	0.013%	19.83%
17	3450	16.08%	0.188%	0.012%	16.28%
18	1200	20.28%	0.181%	0.013%	20.47%
19	3500	15.88%	0.155%	0.016%	16.05%
20	1400	21.48%	0.333%	0.011%	21.82%
21	1300	24.28%	0.287%	0.012%	24.58%
22	1200	24.98%	0.298%	0.016%	25.29%
23	1200	24.18%	0.377%	0.018%	24.57%
24	900	26.78%	0.388%	0.015%	27.18%
25	3350	15.38%	0.332%	0.011%	15.72%
26	1100	22.38%	0.152%	0.013%	22.54%
27	1200	19.18%	0.307%	0.012%	19.49%
28	5400	9.78%	0.242%	0.012%	10.03%
29	1500	20.78%	0.125%	0.010%	20.91%
30	1600	19.38%	0.242%	0.010%	19.63%

Table 8 Magazine printing data

Chapter Four

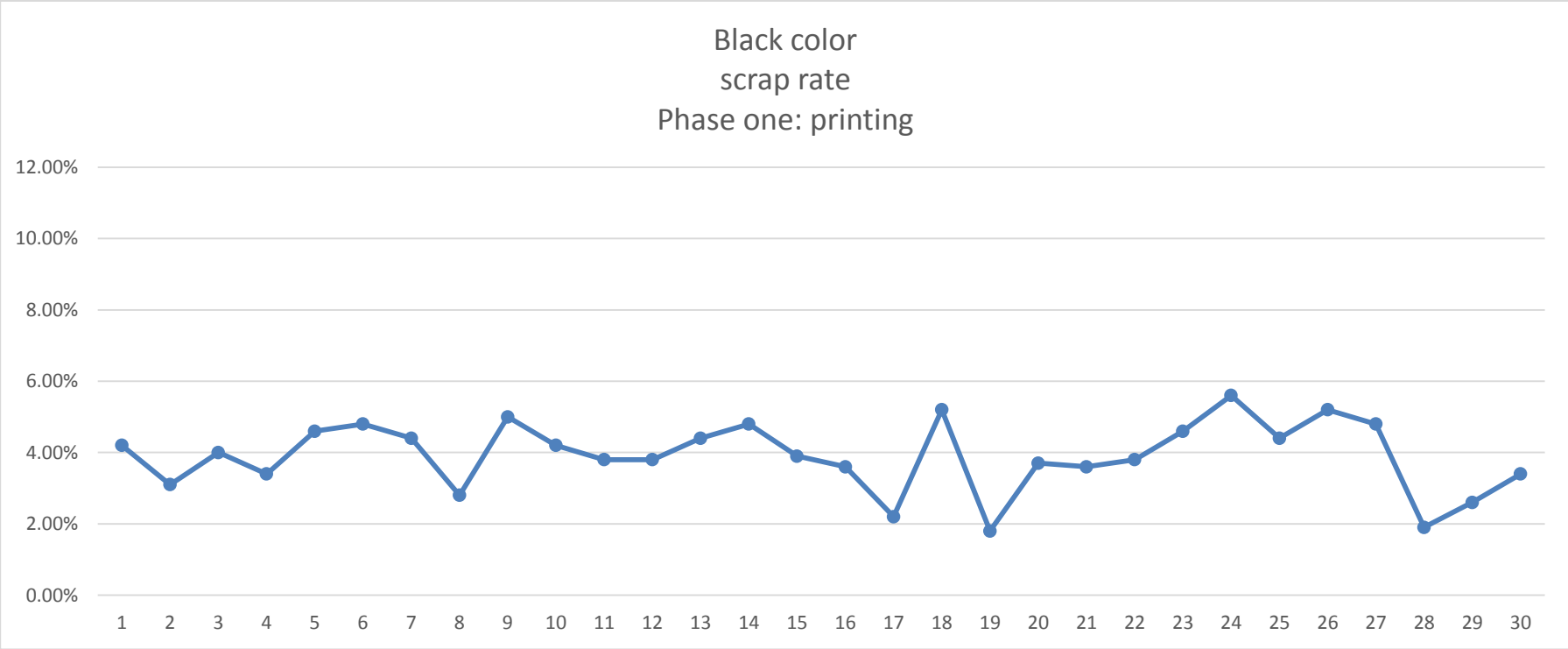
RESULTS AND CONCLUSION

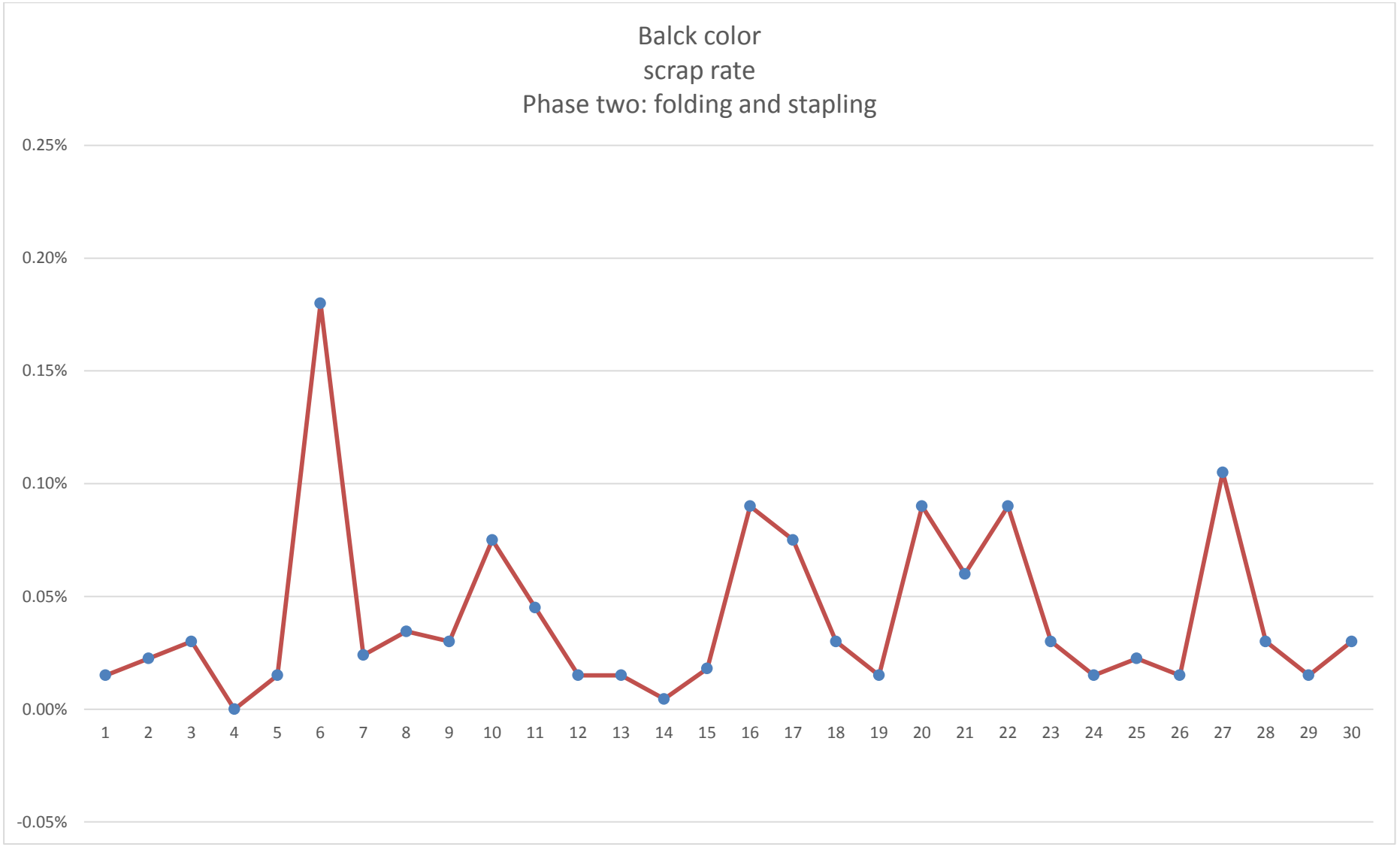
4 RESULTS AND CONCLUSION

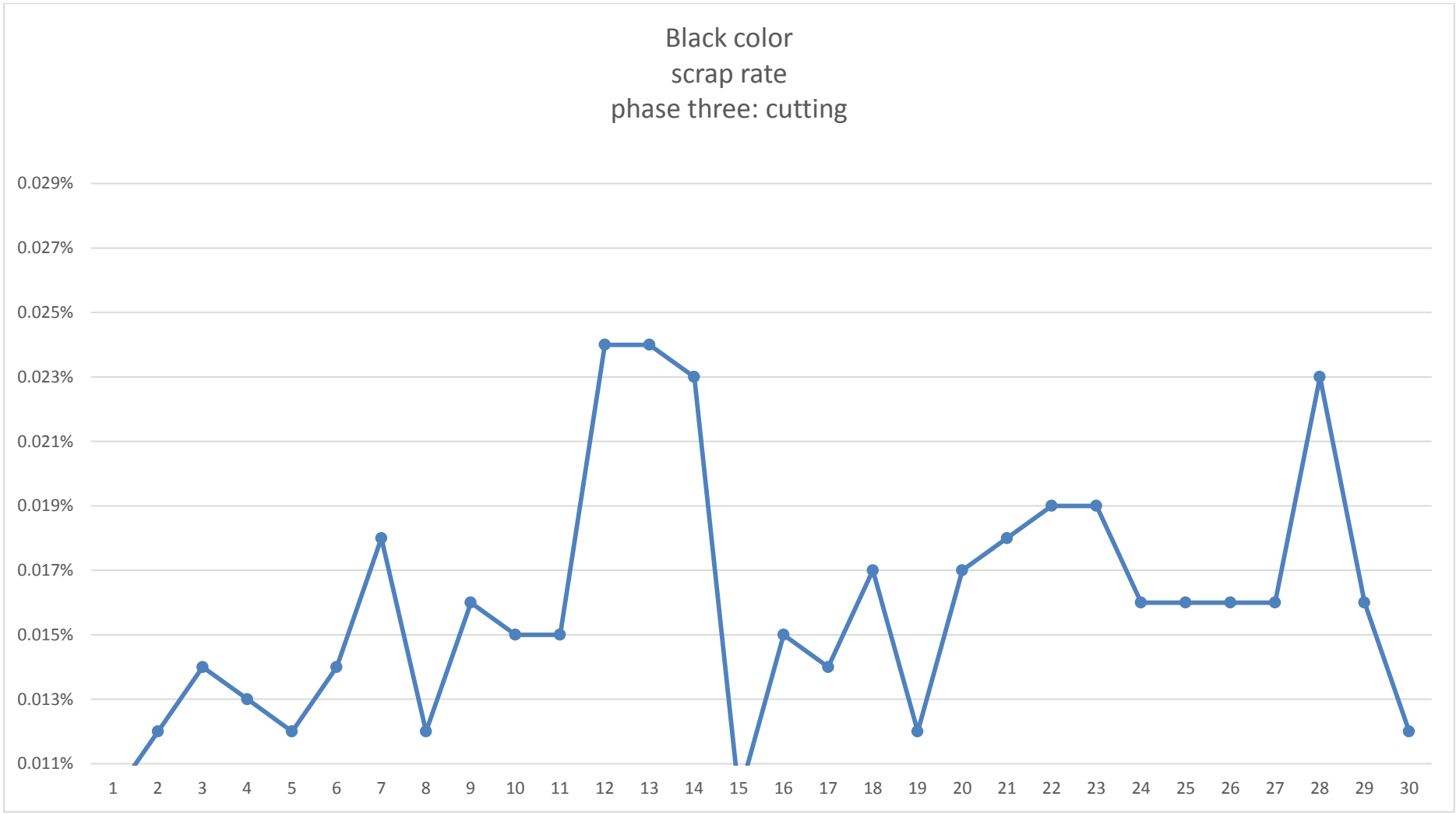
4.1 SCRAP RATE GRAPHS

To comprehend the amount of waste, several graphs were made to illustrate the waste in each process as follows:

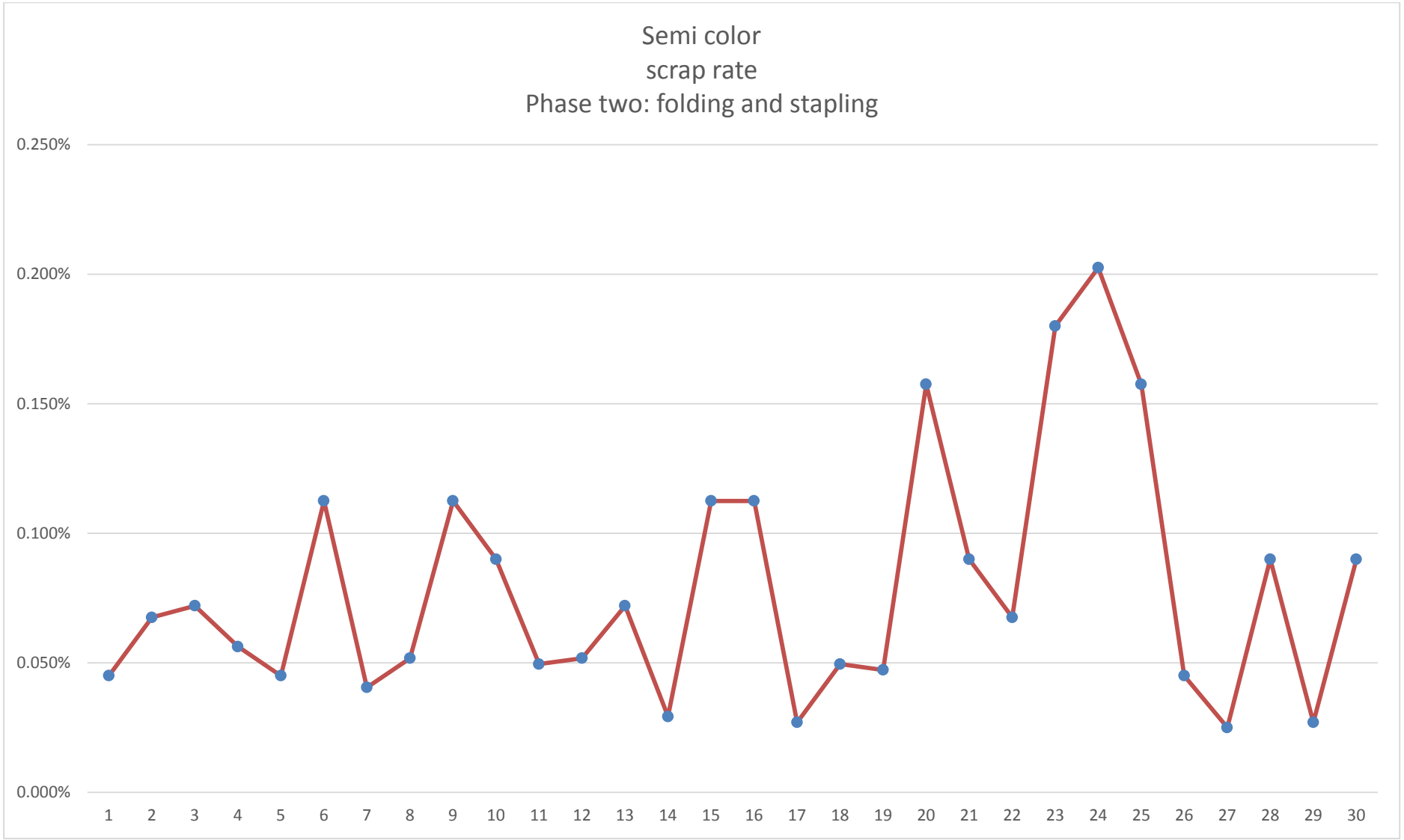
4.1.1 Black color graphs

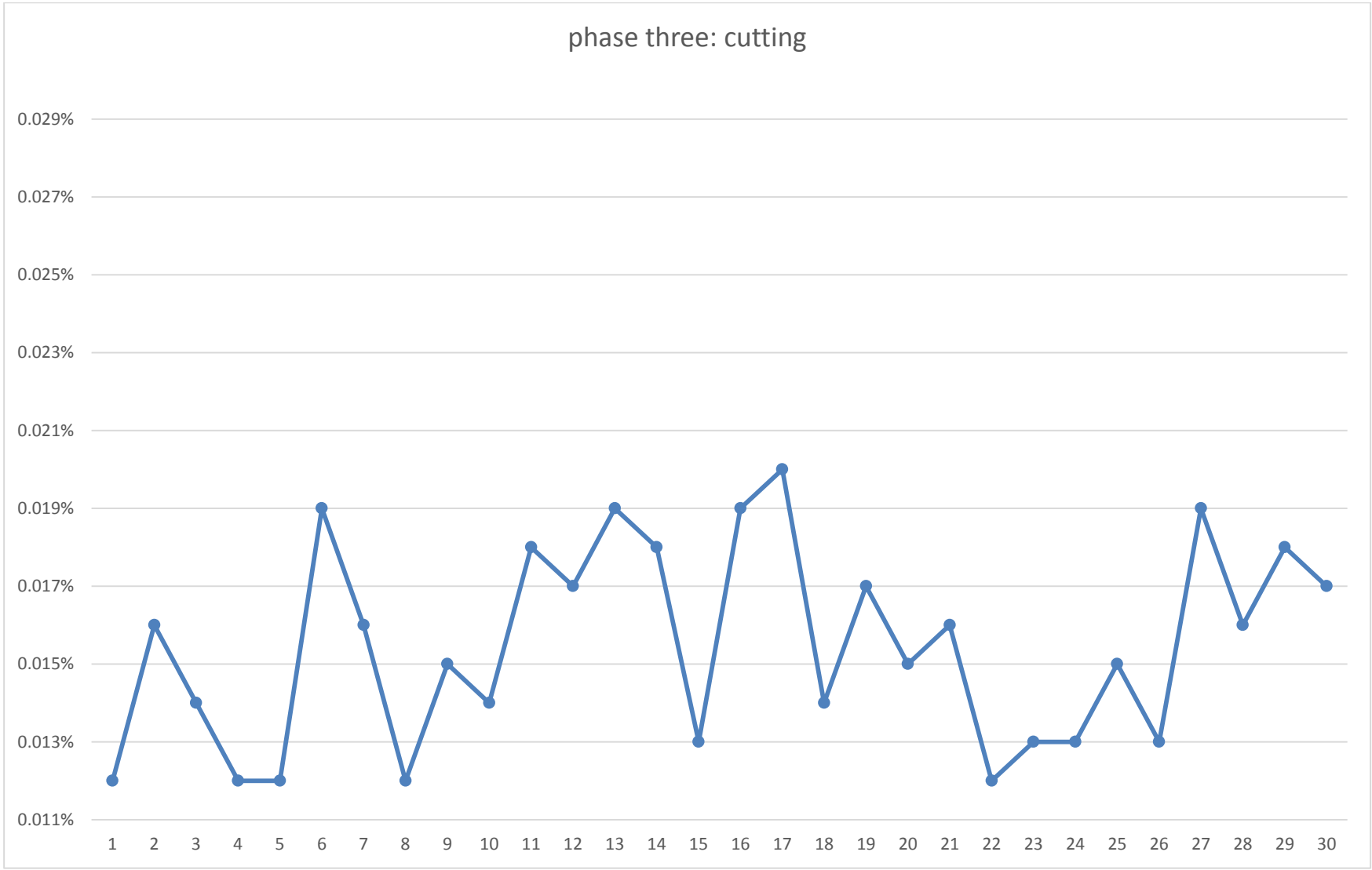



Balck color
scrap rate
Phase two: folding and stapling
0.25%
0.20%
0.15%
0.10%
0.05%
0.00%
-0.05%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

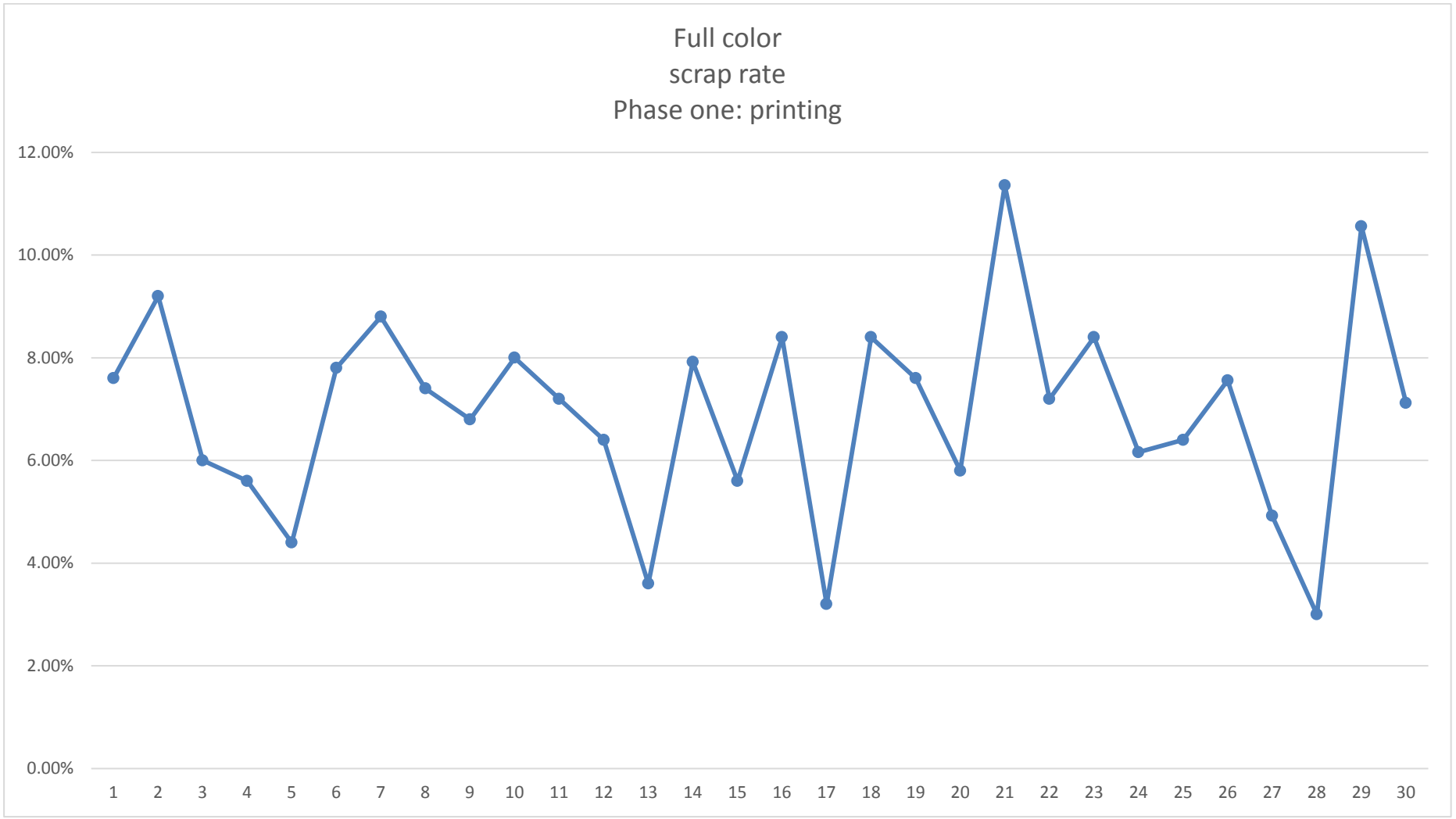

Black color
scrap rate
phase three: cutting
0.029%
0.027%
0.025%
0.023%
0.021%
0.019%
0.017%
0.015%
0.013%
0.011%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

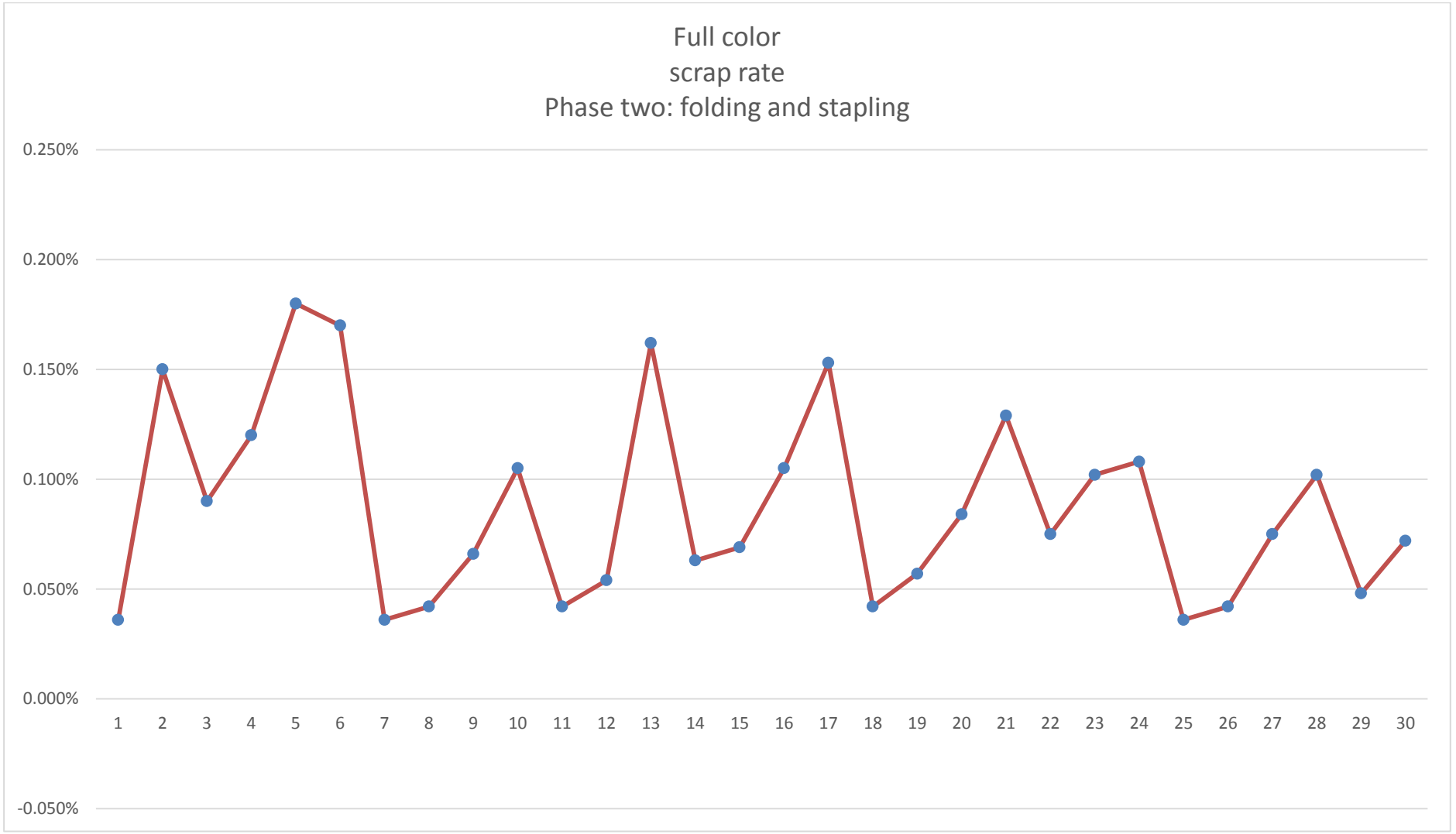
4.1.2 Semi color graphs

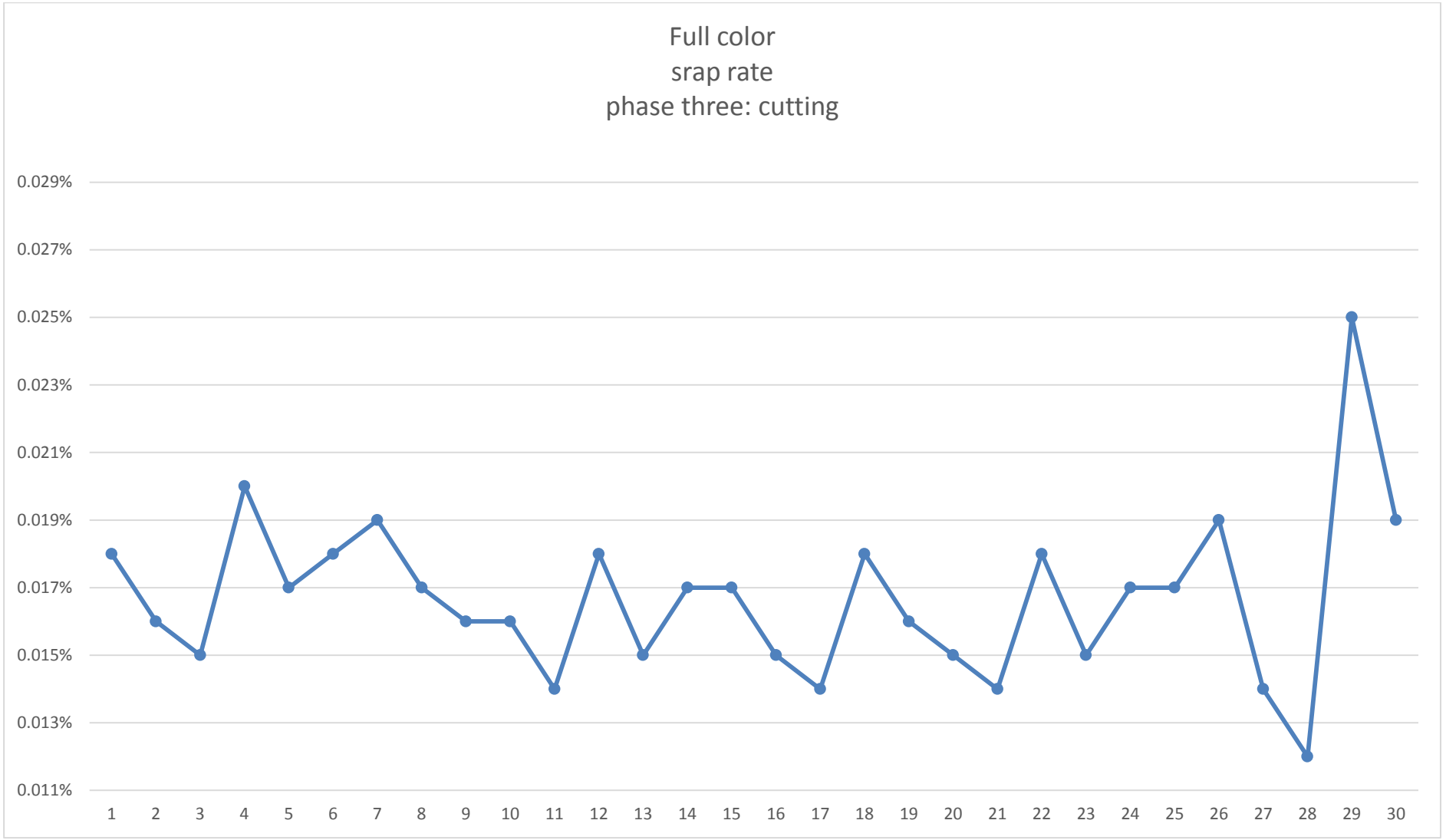

Semi color
scrap rate
Phase two: folding and stapling
0.250%
0.200%
0.150%
0.100%
0.050%
0.000%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30


phase three: cutting
0.029%
0.027%
0.025%
0.023%
0.021%
0.019%
0.017%
0.015%
0.013%
0.011%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

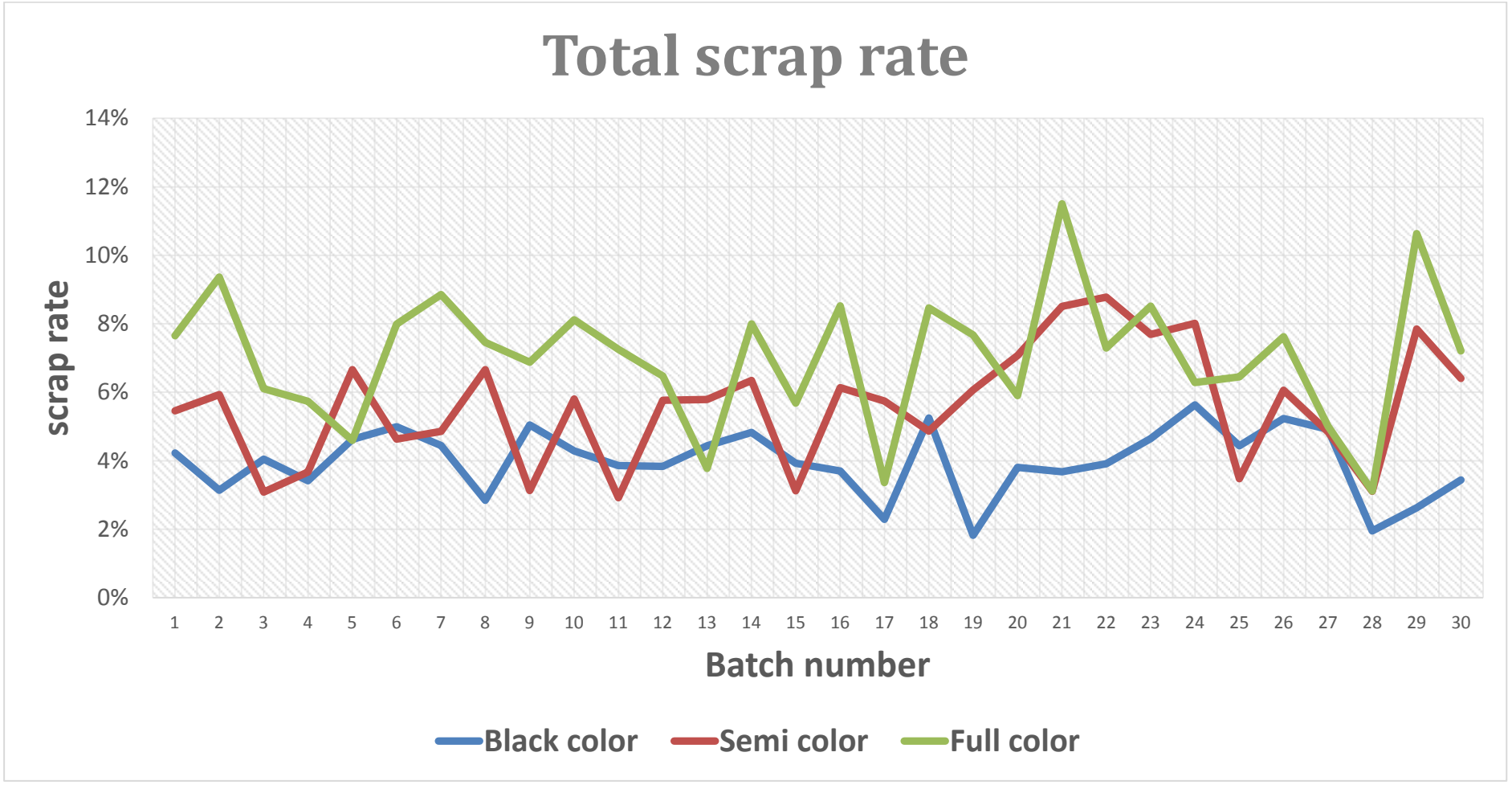
4.1.3 Full Color graphs




Full color
scrap rate
Phase two: folding and stapling
0.250%
0.200%
0.150%
0.100%
0.050%
0.000%
-0.050%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30


Full color
srap rate
phase three: cutting
0.029%
0.027%
0.025%
0.023%
0.021%
0.019%
0.017%
0.015%
0.013%
0.011%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

4.1.4 Total book scrap rate graph



4.2 SCRAP RATE EVALUATION

From the data acquired from black color printing it was evident that the printing process greatly contributes to overall scrap rate more that both the folding and stapling and the cutting. The highest scrap rate was 5.6% in printing. While it was noticed the folding and stapling came second but by a huge margin from printing. The highest scrap was 0.18% in folding and stapling. The least scrap rate came from cutting but also closer to folding and stapling. The highest scrap rate was 0.024% in cutting.

for semi color printing it was obvious that the printing process greatly contributes to overall scrap rate more that both the folding and stapling and the cutting. The highest scrap rate was 8.7% in printing. While it was noticed the folding and stapling came second but by a huge margin from printing. The highest scrap was 0.18% in folding and stapling. The least scrap rate came from cutting but also closer to folding and stapling. The highest scrap rate was 0.020% in cutting.

Similar to black color and semi color, in full color the data showed that the printing process greatly contributes to overall scrap rate more that both the folding and stapling and the cutting. The highest scrap rate was 11.36% in printing. While it was noticed the folding and stapling came second but by a huge margin from printing. The highest scrap was 0.18% in folding and stapling. The least scrap rate came from cutting but also closer to folding and stapling. The highest scrap rate was 0.025% in cutting.

For magazines the data showed that the printing process greatly contributes to overall scrap rate more that both the folding and stapling and the cutting. The highest scrap rate was 26.78% in printing. While it was noticed the folding and stapling came second but by a huge margin from printing. The highest scrap was 0.388% in folding and stapling. The least scrap rate came from cutting but also closer to folding and stapling. The highest scrap rate was 0.019% in cutting

Comparing the three above, it was noticed that in terms of printing, the most scrap rate was by full color printing followed by semi color and last the black color, but in terms of folding and stapling and cutting the there wasn't much of a difference. when the comparison was between magazines and books, magazines had the largest scrap rate in terms of printing and folding and stapling but there was no difference in cutting.

4.3 COST OF SCRAP RATE

Batch number	Batch size	Phase one: printing	Phase two: folding & stapling	phase three: cutting	Total scrap rate	number of scrap books	total number of pages (average)	total cost of scrap paper in SDG (average)
							144	0.23
1	500	4.20%	0.015%	0.010%	4.225%	21.13	3042.00	699.66
2	1,000	3.10%	0.023%	0.012%	3.135%	31.35	4513.68	1,038.15
3	620	4.00%	0.030%	0.014%	4.044%	25.07	3610.48	830.41
4	900	3.40%	0.000%	0.013%	3.413%	30.72	4423.25	1,017.35
5	350	4.60%	0.015%	0.012%	4.627%	16.19	2332.01	536.36
6	320	4.80%	0.180%	0.014%	4.994%	15.98	2301.24	529.28
7	450	4.40%	0.024%	0.018%	4.442%	19.99	2878.42	662.04
8	1,500	2.80%	0.035%	0.012%	2.847%	42.70	6148.44	1,414.14
9	500	5.00%	0.030%	0.016%	5.046%	25.23	3633.12	835.62
10	510	4.20%	0.075%	0.015%	4.290%	21.88	3150.58	724.63
11	600	3.80%	0.045%	0.015%	3.860%	23.16	3335.04	767.06
12	520	3.80%	0.015%	0.060%	3.875%	20.15	2901.60	667.37
13	530	4.40%	0.015%	0.040%	4.455%	23.61	3400.06	782.01
14	500	4.80%	0.005%	0.023%	4.828%	24.14	3475.80	799.43
15	600	3.90%	0.018%	0.010%	3.928%	23.57	3393.79	780.57
16	620	3.60%	0.090%	0.015%	3.705%	22.97	3307.82	760.80
17	2,600	2.20%	0.075%	0.014%	2.289%	59.51	8570.02	1,971.10
18	450	5.20%	0.030%	0.017%	5.247%	23.61	3400.06	782.01
19	3,000	1.80%	0.015%	0.012%	1.827%	54.81	7892.64	1,815.31
20	560	3.70%	0.090%	0.017%	3.807%	21.32	3069.96	706.09
21	700	3.60%	0.060%	0.018%	3.678%	25.75	3707.42	852.71
22	700	3.80%	0.090%	0.019%	3.909%	27.36	3940.27	906.26
23	650	4.60%	0.030%	0.019%	4.649%	30.22	4351.46	1,000.84
24	320	5.60%	0.015%	0.016%	5.631%	18.02	2594.76	596.80
25	440	4.40%	0.023%	0.016%	4.439%	19.53	2812.23	646.81
26	350	5.20%	0.015%	0.016%	5.231%	18.31	2636.42	606.38
27	560	4.80%	0.105%	0.016%	4.921%	27.56	3968.29	912.71
28	3,000	1.90%	0.030%	0.023%	1.953%	58.59	8436.96	1,940.50
29	1,000	2.60%	0.015%	0.016%	2.631%	26.31	3788.64	871.39
30	850	3.40%	0.030%	0.012%	3.442%	29.26	4213.01	968.99
TOTAL BATCH SIZE	25,200		TOTAL COST OF SCRAP PAPER					27,422.8
			TOTAL COST OF PAPER					834,624.0

Table 9 Black color scrap cost

Batch number	Batch size	Phase one: printing	Phase two: folding & stapling	phase three: cutting	Total scrap rate	number of scrap books	total number of pages (average)	total cost of scrap paper in SDG (average)
							144	0.23
1	700	5.40%	0.045%	0.012%	5.457%	38.20	5500.66	1,265.2
2	500	5.85%	0.068%	0.016%	5.934%	29.67	4272.12	982.6
3	1000	3.00%	0.072%	0.014%	3.086%	30.86	4443.84	1,022.1
4	800	3.60%	0.056%	0.012%	3.668%	29.35	4225.82	971.9
5	450	6.60%	0.045%	0.012%	6.657%	29.96	4313.74	992.2
6	750	4.50%	0.113%	0.019%	4.632%	34.74	5002.02	1,150.5
7	600	4.80%	0.041%	0.016%	4.857%	29.14	4196.02	965.1
8	550	6.60%	0.052%	0.012%	6.664%	36.65	5277.69	1,213.9
9	2000	3.00%	0.113%	0.015%	3.128%	62.55	9007.20	2,071.7
10	750	5.70%	0.090%	0.014%	5.804%	43.53	6268.32	1,441.7
11	3000	2.85%	0.495%	0.018%	3.363%	100.89	14528.16	3,341.5
12	550	5.70%	0.052%	0.017%	5.769%	31.73	4568.85	1,050.8
13	750	5.70%	0.072%	0.019%	5.791%	43.43	6254.28	1,438.5
14	850	6.30%	0.029%	0.018%	6.347%	53.95	7769.03	1,786.9
15	1500	3.00%	0.113%	0.013%	3.126%	46.88	6751.08	1,552.7
16	660	6.00%	0.113%	0.019%	6.132%	40.47	5827.38	1,340.3
17	950	5.70%	0.027%	0.020%	5.747%	54.60	7861.90	1,808.2
18	800	4.80%	0.050%	0.014%	4.864%	38.91	5602.75	1,288.6
19	600	6.00%	0.047%	0.017%	6.064%	36.39	5239.51	1,205.1
20	940	6.90%	0.158%	0.015%	7.073%	66.48	9573.34	2,201.9
21	700	8.40%	0.090%	0.016%	8.506%	59.54	8574.05	1,972.0
22	550	8.70%	0.068%	0.012%	8.780%	48.29	6953.36	1,599.3
23	660	7.50%	0.180%	0.013%	7.693%	50.77	7311.43	1,681.6
24	560	7.80%	0.203%	0.013%	8.016%	44.89	6463.70	1,486.7
25	3000	3.30%	0.158%	0.015%	3.473%	104.18	15001.20	3,450.3
26	900	6.00%	0.045%	0.013%	6.058%	54.52	7851.17	1,805.8
27	700	4.80%	1.125%	0.019%	5.944%	41.61	5991.55	1,378.1
28	2500	3.00%	0.090%	0.016%	3.106%	77.65	11181.60	2,571.8
29	500	7.80%	0.027%	0.018%	7.845%	39.23	5648.40	1,299.1
30	800	6.30%	0.090%	0.017%	6.407%	51.26	7380.86	1,697.6
TOTAL BATCH SIZE	29,570		TOTAL COST OF SCRAP PAPER (SDG)					48,033.4
			TOTAL COST OF PAPER (SDG)					979,358.4

Table 10 semi color scrap cost

Batch number	Batch size	Phase one: printing	Phase two: folding & stapling	phase three: cutting	Total scrap rate	number of scrap books	total number of pages (average)	total cost of scrap paper in SDG (average)
							144	0.23
1	700	7.60%	0.036%	0.018%	7.654%	53.58	7715.23	1,774.5
2	550	9.20%	0.150%	0.016%	9.366%	51.51	7417.87	1,706.1
3	900	6.00%	0.090%	0.015%	6.105%	54.95	7912.08	1,819.8
4	1000	5.60%	0.120%	0.020%	5.740%	57.40	8265.60	1,901.1
5	2000	4.40%	0.180%	0.017%	4.597%	91.94	13239.36	3,045.1
6	600	7.80%	0.270%	0.018%	8.088%	48.53	6988.03	1,607.2
7	450	8.80%	0.036%	0.019%	8.855%	39.85	5738.04	1,319.7
8	880	7.40%	0.042%	0.017%	7.459%	65.64	9452.04	2,174.0
9	850	6.80%	0.066%	0.016%	6.882%	58.50	8423.57	1,937.4
10	650	8.00%	0.105%	0.016%	8.121%	52.79	7601.26	1,748.3
11	700	7.20%	0.042%	0.014%	7.256%	50.79	7314.05	1,682.2
12	900	6.40%	0.054%	0.018%	6.472%	58.25	8387.71	1,929.2
13	2000	3.60%	0.162%	0.015%	3.777%	75.54	10877.76	2,501.9
14	500	7.92%	0.063%	0.017%	8.000%	40.00	5760.00	1,324.8
15	800	5.60%	0.069%	0.017%	5.686%	45.49	6550.27	1,506.6
16	600	8.40%	0.105%	0.015%	8.520%	51.12	7361.28	1,693.1
17	3000	3.20%	0.153%	0.014%	3.367%	101.01	14545.44	3,345.5
18	500	8.40%	0.042%	0.018%	8.460%	42.30	6091.20	1,401.0
19	800	7.60%	0.057%	0.016%	7.673%	61.38	8839.30	2,033.0
20	900	5.80%	0.084%	0.015%	5.899%	53.09	7645.10	1,758.4
21	400	11.36%	0.129%	0.014%	11.503%	46.01	6625.73	1,523.9
22	700	7.20%	0.075%	0.018%	7.293%	51.05	7351.34	1,690.8
23	600	8.40%	0.102%	0.015%	8.517%	51.10	7358.69	1,692.5
24	950	6.16%	0.108%	0.017%	6.285%	59.71	8597.88	1,977.5
25	770	6.40%	0.036%	0.017%	6.453%	49.69	7155.09	1,645.7
26	600	7.56%	0.042%	0.019%	7.621%	45.73	6584.54	1,514.4
27	800	4.92%	0.075%	0.014%	5.009%	40.07	5770.37	1,327.2
28	3000	3.00%	0.102%	0.012%	3.114%	93.42	13452.48	3,094.1
29	500	10.56%	0.048%	0.025%	10.633%	53.17	7655.76	1,760.8
30	900	7.12%	0.072%	0.019%	7.211%	64.90	9345.46	2,149.5
TOTAL BATCH SIZE	28,500		TOTAL COST OF SCRAP PAPER (SDG)					56,585.2
			TOTAL COST OF PAPER (SDG)					943,920.0

Table 11 full color scrap cost

Batch number	Batch size	Phase one: printing	Phase two: folding & stapling	phase three: cutting	Total scrap rate	number of scrap books	total number of pages (average)	total cost of scrap paper in SDG (average)
							72	0.3
1	1100	19.60%	0.126%	0.012%	19.74%	217.12	15632.5	4,689.7
2	1500	18.30%	0.171%	0.014%	18.49%	277.28	19963.8	5,989.1
3	1500	14.40%	0.189%	0.011%	14.60%	219.00	15768.0	4,730.4
4	1550	14.40%	0.120%	0.012%	14.53%	225.25	16218.1	4,865.4
5	750	22.80%	0.126%	0.016%	22.94%	172.07	12388.7	3,716.6
6	1250	19.00%	0.475%	0.012%	19.49%	243.58	17538.1	5,261.4
7	900	18.80%	0.133%	0.010%	18.94%	170.48	12274.9	3,682.5
8	1900	19.20%	0.165%	0.011%	19.38%	368.15	26506.9	7,952.1
9	2300	16.40%	0.250%	0.012%	16.66%	383.22	27591.9	8,277.6
10	1100	20.20%	0.282%	0.014%	20.50%	225.46	16232.8	4,869.8
11	3500	13.70%	0.845%	0.019%	14.56%	509.72	36700.0	11,010.0
12	1000	19.40%	0.135%	0.011%	19.55%	195.46	14072.9	4,221.9
13	1200	20.48%	0.165%	0.011%	20.66%	247.87	17846.8	5,354.0
14	1250	22.48%	0.085%	0.011%	22.58%	282.20	20318.5	6,095.6
15	2000	14.08%	0.230%	0.012%	14.32%	286.45	20624.0	6,187.2
16	1500	19.48%	0.338%	0.013%	19.83%	297.47	21417.8	6,425.3
17	3450	16.08%	0.188%	0.012%	16.28%	561.64	40438.3	12,131.5
18	1200	20.28%	0.181%	0.013%	20.47%	245.69	17689.3	5,306.8
19	3500	15.88%	0.155%	0.016%	16.05%	561.78	40448.2	12,134.5
20	1400	21.48%	0.433%	0.011%	21.92%	306.93	22099.1	6,629.7
21	1300	24.28%	0.287%	0.012%	24.58%	319.52	23005.5	6,901.6
22	1200	24.98%	0.298%	0.016%	25.29%	303.48	21850.3	6,555.1
23	1200	24.18%	0.377%	0.018%	24.57%	294.85	21228.9	6,368.7
24	900	26.78%	0.388%	0.015%	27.18%	244.61	17611.8	5,283.5
25	3350	15.38%	0.332%	0.011%	15.72%	526.57	37913.0	11,373.9
26	1100	22.38%	0.152%	0.013%	22.54%	247.95	17852.1	5,355.6
27	1200	19.18%	1.907%	0.012%	21.09%	253.13	18225.6	5,467.7
28	5400	9.78%	0.242%	0.012%	10.03%	541.59	38994.7	11,698.4
29	1500	20.78%	0.125%	0.010%	20.91%	313.66	22583.3	6,775.0
30	1600	19.38%	0.242%	0.010%	19.63%	314.04	22610.9	6,783.3
TOTAL BATCH SIZE	52,600		TOTAL COST OF SCRAP PAPER (SDG)					202,094.0
			TOTAL COST OF PAPER (SDG)					1,136,160.0

Table 12 magazine scrap cost

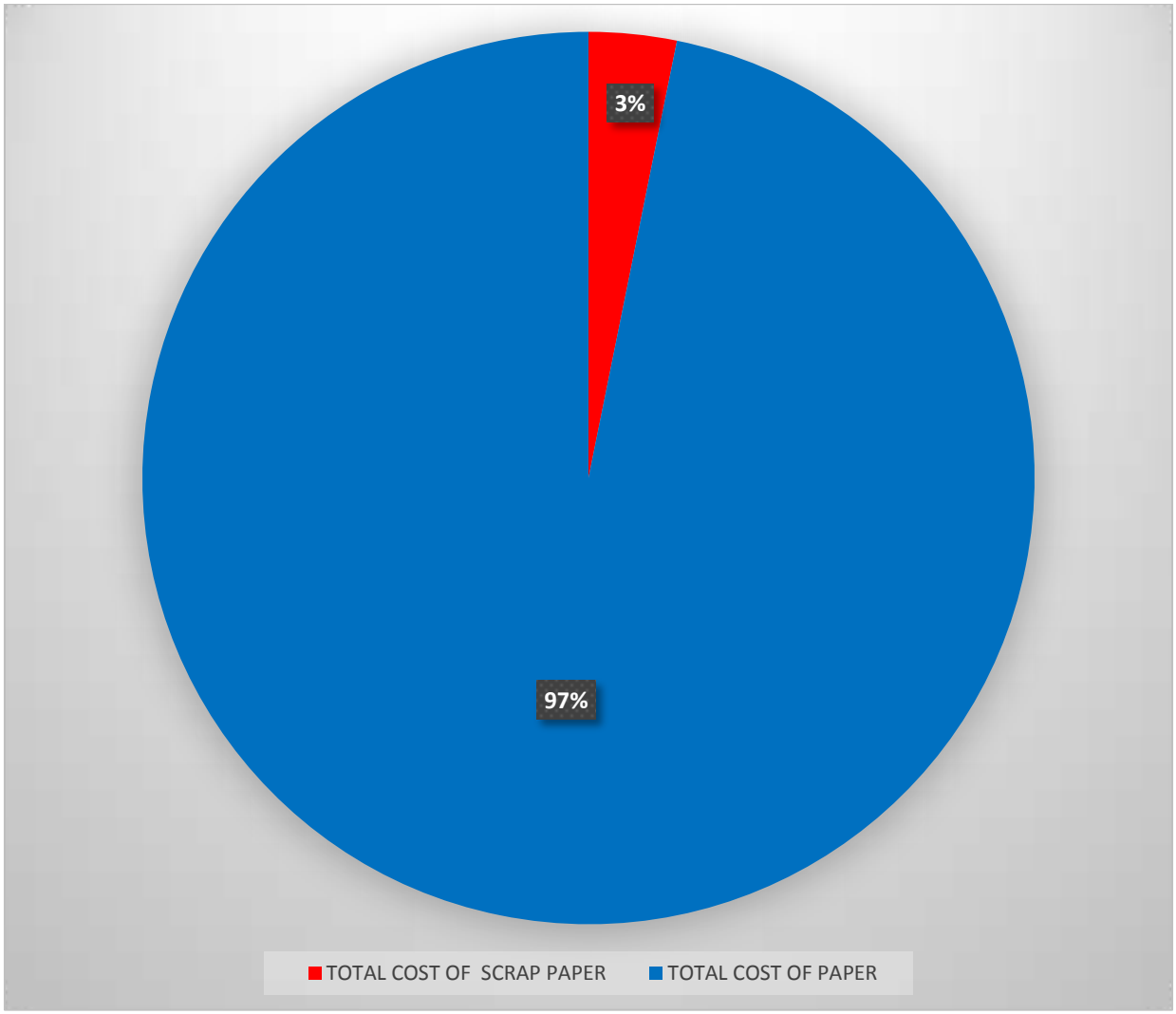


Figure 7 Total cost of scrap paper black color

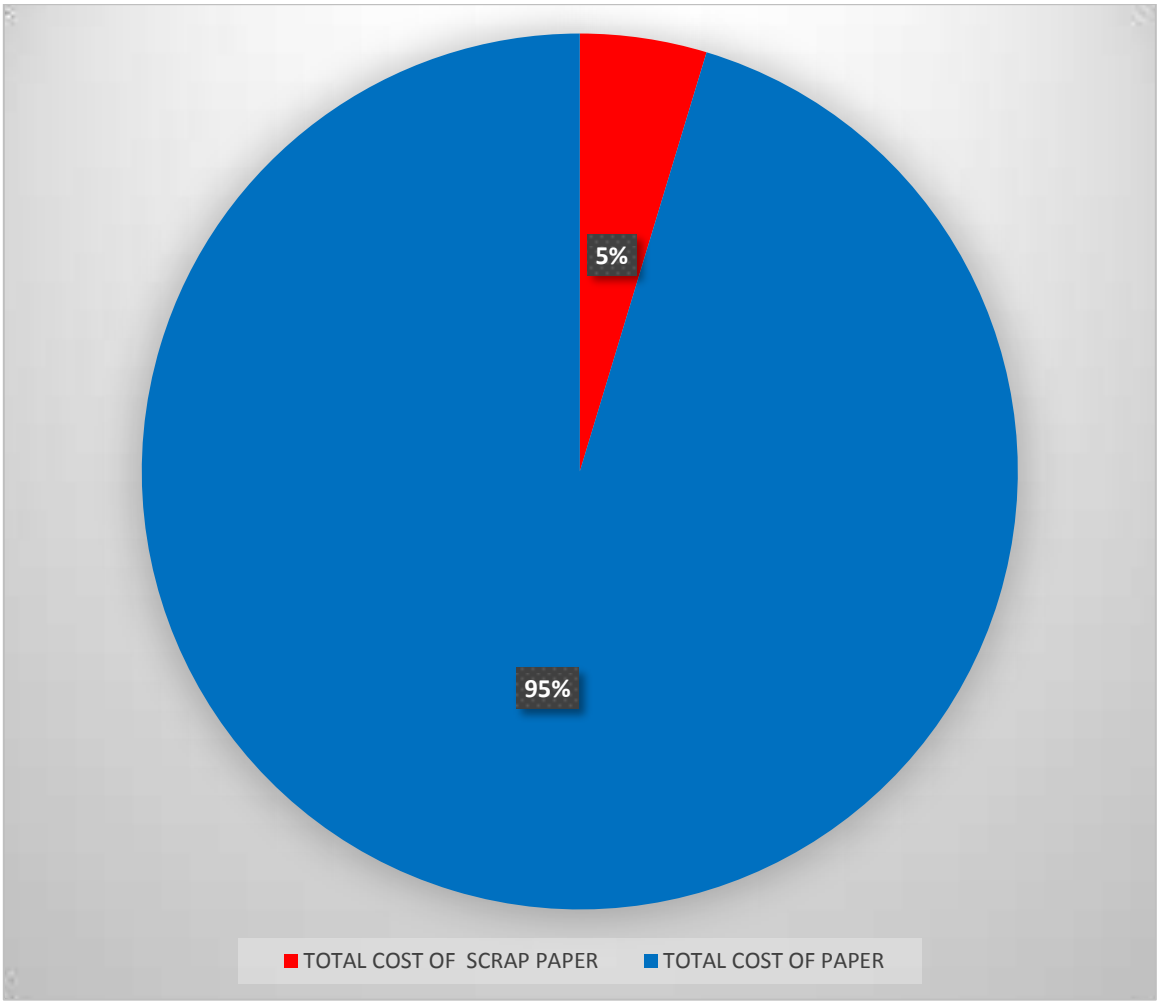


Figure 8 Total cost of scrap paper semi color

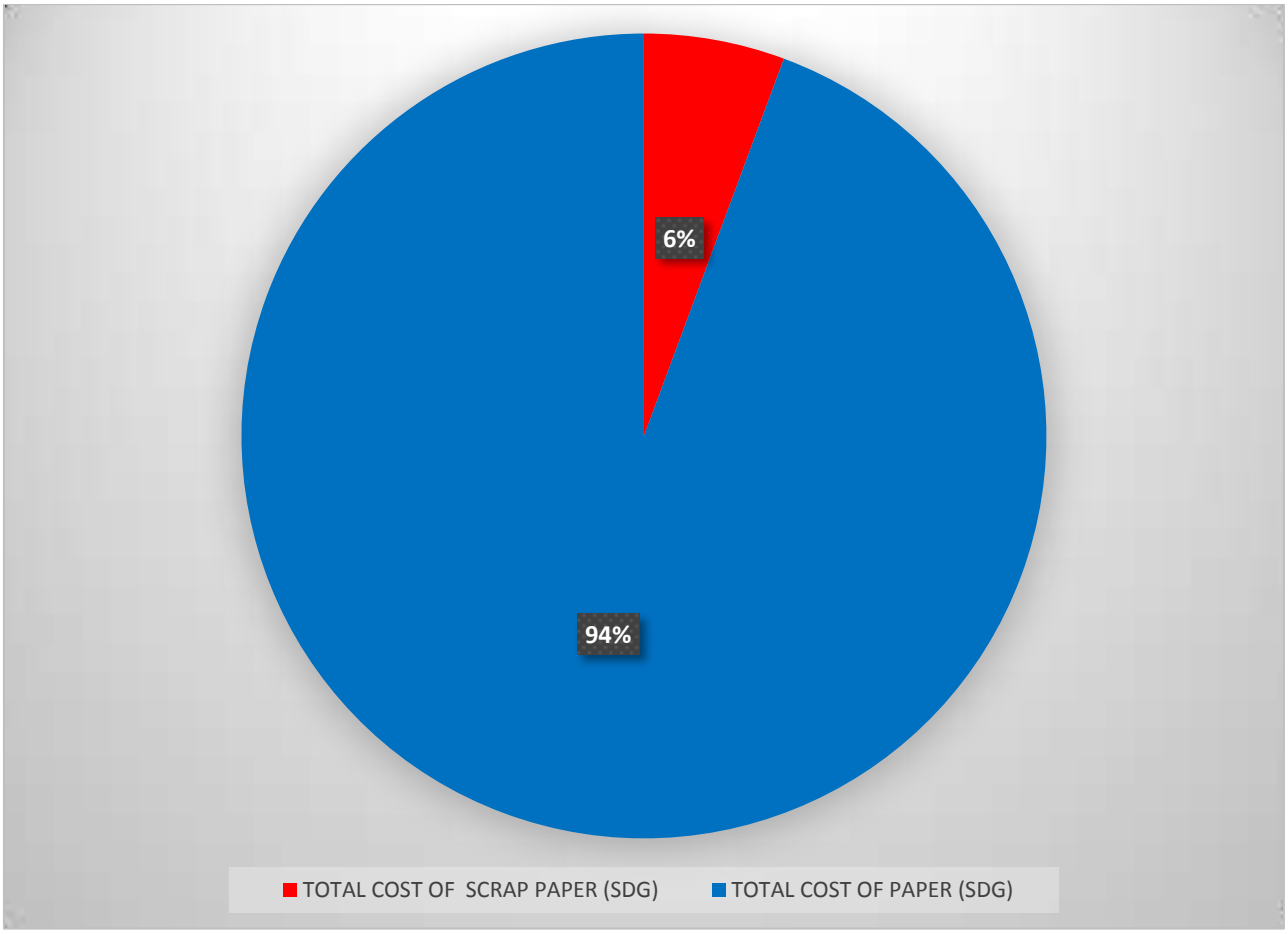


Figure 9 Total cost of scrap paper full color

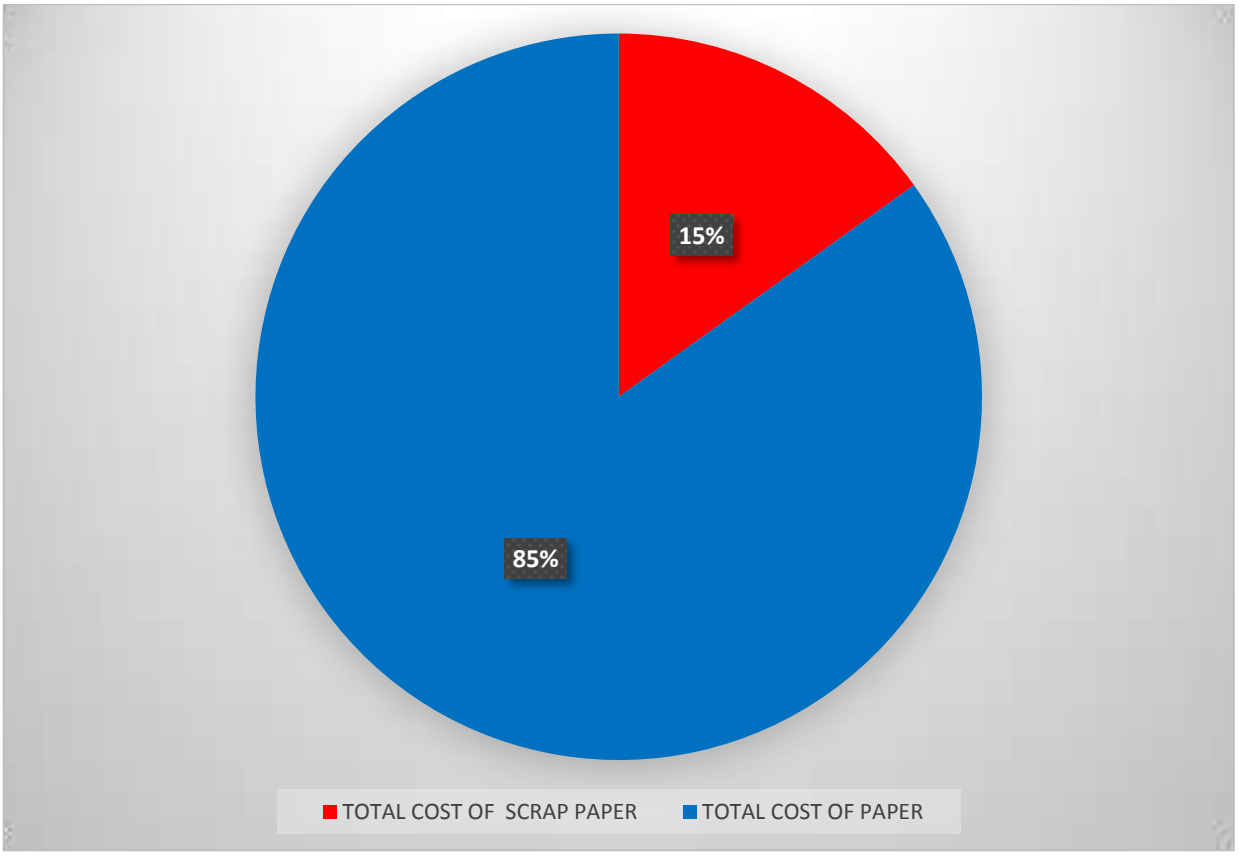


Figure 10 Total cost of scrap paper magazine

Chapter Five

RECOMMENDATIONS

5 RECOMMENDATIONS

It was evident from the results that lots of waste was originating from paper, and when a monetary value was put into the equation lots of pounds were lost due to this waste making the printing press overcharge customers for waste that is of no value to the customer. The first step is to of course eliminate this waste, this can be done in numerous ways but initially to make sure that machines run properly so that no run produces waste. The best way is that if a machine starts making waste simply stop it immediately till the problem is resolved.

Although production maybe affected but intermediate quality control checks are necessary to ensure that the whole run does not produce waste. If the production run is divided into segments and then the quality is checked in those sections it would ensure that the error be identified as early as possible.

Training of personnel is also essential to conduct both the printi8ng operations and the relevant quality control checks. This is due to the fact that in the current situation the only method available to detect defects is by humans. They must be able to identify defects as soon as possible and as quickly as possible.

It is also recommended that an investment to acquire new advanced machinery should be studied, the results obtained from the research show the loss in income due to waste, if this monetary waste could be diverted into getting a new machine with zero paper waste due to advanced setup methods. And also we can overhaul machines in the company.

Further studies should also identify other means of waste in the printing press as well as studying the implementation of lean manufacturing to quickly identify waste and defects as well as making sure the production is not affected during the quality control checks and machine stoppage.

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