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Print Production Enhancement by Reducing Process Wastage in Printing & Packaging Industry

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Abstract: **-** This research study is focused on the analysis of waste generation and its optimization in the press and post-press sections of a printing press. The primary objective is to assess the different types of waste, their prospective causes and to suggest suitable measures to optimize the production process. A comprehensive analysis of production data of four-month period from four printing machines (Heidelberg CD-102UV, CD-74, CX-102, CD102E) showed a cumulative waste of 4,390,4031 prints, with a corresponding waste percentage of 2.43%. The in-depth analysis further showed that top three waste among all were printing waste (2.43%), Auto die punching (0.31%) and lamination (0.17%) among others. The printing waste majorly constituted shade variations due to design corrections, dampening solution issues, problems in ink mixtures, machine malfunctions (such as roller problems), and set-off. Auto die punching waste primarily occurred due to side pin and gripper issues while major issue contributing to lamination waste was lamination wrinkling. As the printing market is getting much fiercer these days, printers are required to increase their resource efficiency and waste reduction.

The study also noted that the running wastage (4.77% - February, 5.78% - March, 4.34%-April) was significantly higher than the proposed target waste (3.50%). Based on the analysis, corrective measures have been suggested to optimize the production and reduce the waste. These include implementing targeted strategies to address identified issues, such as improving the accuracy of design corrections, ensuring the correct pH (4.5-5.5) and conductivity (<800µS/cm), training for correct mixture of ink based on ink manufacturer guideline, preventive maintenance of machinery and maintaining proper environmental conditions (24 °C and 65% RH).The study emphasise the importance of continuous monitoring and the implementation of quality control measures to detect and mitigate potential sources of waste in the production process.

Keywords: Waste Minimization, Offset Printing, Press, Post-press, Defects.

1. Introduction

Three stages are involved in the production of a printed product: prepress, the actual printing process (press), and finishing (post-press). Numerous raw materials are required to connect the separate stages such as printing plates which connect prepress and press and printed sheets which connect press and post-press (Kipphan, 2001). The production flow, materials, and data for print media production are shown in Figure 1.

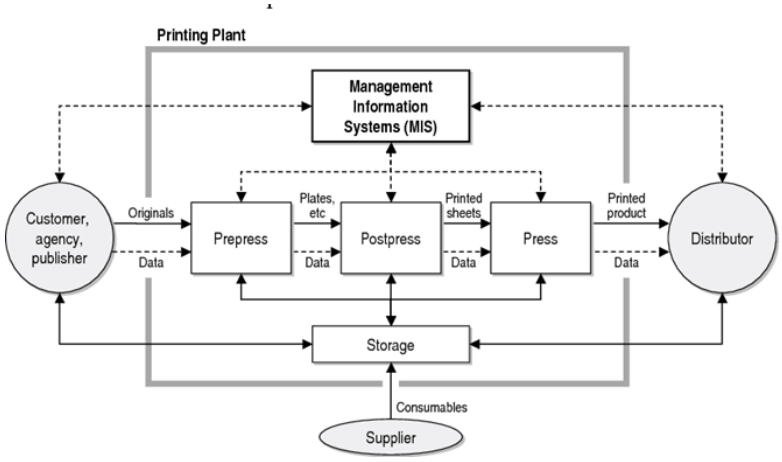

Figure 1. Print Production Workflow (Kipphan, 2001; Buckwalter, 2006)

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There is a lot of pressure on the printing industry to lower costs and increase efficiency because of rising raw material costs and global overcapacity. Printers need to enhance their sustainable practices because there are more legal and consumer demands for reducing the environmental impact of industry operations. Paper is very costly and precious item in the print production. Paper is a crucial component of print-production methods, accounting for approximately 60-70% of total production costs in any printing facility (Varma, 2012). Figure 2. displays schematic of waste management techniques used in the paper/paperboard industry according to their frequency of their use.

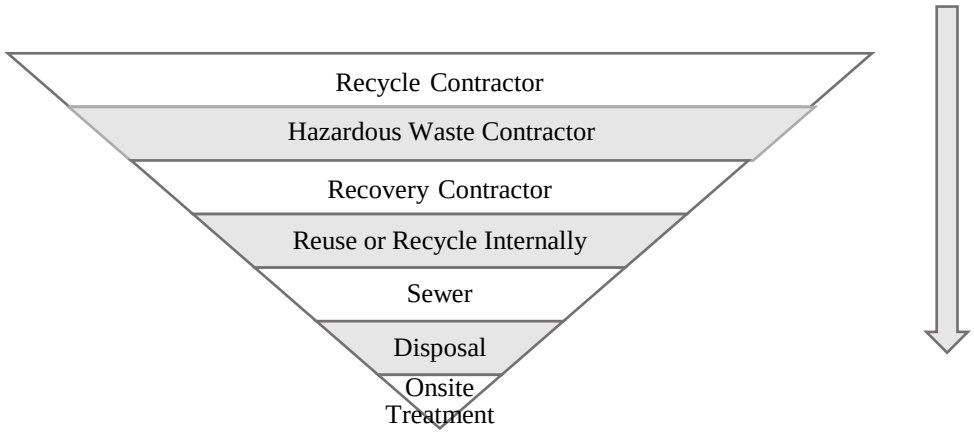

Figure 1. Waste management techniques used in the paper/paperboard industry according to their frequency of their use (Boora & Batra, 2017)

Waste is traditionally thought of as an extraneous byproduct of any industry's operations. Unfortunately, a large portion of today's natural resources are wasted due to unsustainable use. A company's waste streams are caused by a variety of practices, which have an adverse effect on the environment and its finances. These practices include using excessive raw materials, underusing resources, using scrap parts, and using outdated materials (Franchetti, 2009). One of the primary sources of waste in the printing sector is wasted paper, which has a big financial and environmental impact. Thus, searching for ways to reduce paper waste and implement waste management techniques can present printers with an opportunity to boost output, transition to greener production techniques, and save costs (Lundberg & Wallin, 2016; Boora & Batra, 2017). Paper wastes natural resources and company money when it is returned from production because it is sometimes unable to be reused (Hamerlinski & Pyr'yev, 2014).

The causes and strategies for minimizing the wastage in the printing industry in Ghana's Accra and Kumasi, demonstrated that printing industry immensely produced waste including air emissions, wastewater, and solid waste. In addition to increasing production costs, these wastes pose serious threat to the environment because of incorrect disposal techniques. The waste in the printing industry can be attributed as the result of three main issues: insufficient machinery maintenance, exorbitant spoilage allowances, and a deficiency of efficient waste management procedures (Chea, 2008).

The wastage in printing can be categorized based on its nature, composition, source, and quantity (Table 1). In one of such studies to analyse solid and hazardous waste generation in paper/paper board packaging industry it was found that paper was the major source of wastage which constitute around 88% of the total waste (Boora & Batra, 2017). The study suggests effective waste management strategies, emphasizing recycling within industry premises over selling to scrap contractors for better management and profitability. The study observes that businesses are adopting more environmentally friendly practices, such as printing consumables and using recycled materials. While less common in India, some recycling, silver recovery, and onsite waste treatment plants (ETPs) lower disposal costs and make money for the printing and packaging industries. Table 1. presents the type, source and class of waste generated in a concise format.

Table 1. The Type, Source and Class of Waste Generated (Boora & Batra, 2017)

Type of waste	Description	Source	Waste Class
Paper Waste	Duplex board FBB Grey back and similar boards	Printing, post-press sections	Solid
Ink Waste	UV inks and conventional inks	Make-ready operations	Hazardous
Solvents/Chemicals	Press solvents, blanket wash solutions, gum, delete opaque	Printing operations	Hazardous
Lubricants Waste	Oils and grease used in machines	Machine maintenance	Hazardous
E-waste	Waste from computers, cartridges, damaged densitometers	Prepress department	Hazardous
Plastic Waste	Substrates, packaging materials	Packaging operations	Solid (non-degradable)
Metal Waste	Printing plates, machine spare parts	Printing operations, repairs	Solid

Offset lithography is a widely used method for producing printed materials. Books, stationery, newspapers, magazines, forms, maps, art reproductions, labels, packages and brochures etc. are a few of the jobs commonly printed with offset lithography. In lithographic offset four-colour printing, four primary inks - cyan (C), magenta (M), yellow (Y), and black (K) are used to create different shades of colour (Lundström, Verikas, Tullander, & Larsson, 2013). In offset plates the image and the non-image areas are on the same plane (differences in height between 0.5 and 3 μm) (Baumann & Timpe, 1994). Paper is always wasted in sheet fed offset printing due to production errors and press setup (rejection via quality control procedures). Furthermore, additional time and resources are needed for the finishing processes. Therefore, extra paper should be supplied during the printing process for a specific job in order to account for "unsalable" production (Kipphan, 2001). Press make-ready can be defined as the steps and operations which are necessary to prepare the offset printing press by setting the; inking unit, dampening, infeed unit, printing unit and delivery unit specific to the particular printing job in hand. Currently, multi-colour presses are used extensively, which use various automation systems designed to shorten the make-ready (press setup) time and reduce overall waste (DeJidas & Destree, 2005). Waste can be significantly reduced by following the make-ready process systematically and accurately. The printing press with high degree of automation substantially reduces the waste during the production run (Mehra, S., & Baral, A. K., 2023).

The quality assurance framework that has been developed for offset printing improves efficiency by lowering make-ready and adjustment times, maintaining compliance with ISO 12647-2 standards, and facilitating the prompt identification and correction of printing defects by operators. The demands of the customer for low prices, quick lead times, and high quality are met by this integrated approach (Korytkowski, Olejnik-Krugly, & Zaikin, 2009).

To maintain consistent printing quality, the press operator measures the print quality throughout the job run and the colour deviations are compensated if detected in the print. Usually, the print quality is assessed visually at the initial stage. If deviations, noticeable to the operator eye, are detected, a densitometer/spectrophotometer is then applied to get a numerical evaluation of the colour deviations and adjustments are performed to compensate for the quality difference. The novel approach includes virtual sensors for assessing, evaluating, and investigating print quality attributes related to paper and press parameters (Lundström et al., 2013).

Quality control in the printing industry is important for maintaining high standards and economic viability, requiring both visual and instrumental evaluation methods. Visual checks ensure customer satisfaction by considering elements like register, colour, and deviation. Instrumental evaluation, particularly using a densitometer, provides consistent, quantifiable data on key parameters such as density (SID), chromatic balance, dot gain (TVI), print contrast, and trapping. Print control strips assist in evaluating these parameters during the production process. Adhering to standardized values and continuously comparing with stringent market standards

are essential for achieving and maintaining ISO 9000 certification and surviving in a competitive, automated environment (Srl, 2012).

2. Research Objective

The study is aimed at evaluating the root cause of waste generation in printing and packaging at various stages and suggesting suitable waste reduction strategy in the production process. The primary objective of this research is to calculate and analyse the percentage waste in the printing process on a monthly basis. This includes understanding the different types of wastage and their possible causes such as printing machine issues, lamination, corrugation, manual die punching, auto die punching, stripping, pasting and miscellaneous (Folding, Blister, Planning Waste). Additionally, the corrective measures for sustained waste reduction and process optimization have been suggested.

3. Material and Methods

For this study, production data of four Months (February to May, 2024) of sheet fed offset printing machines (Heidelberg CD-102UV, CD-74, CX-102, CD102E) installed at Edelmann Packaging India Pvt. Ltd., Baddi, Himachal Pradesh were taken into consideration. The Machine Specifications are given as under (Table 2.).

Table 2. The machines specifications (data collected from parent website)

Description	CD-102UV	CX-102	CD102E	CD-74
Number of printing units	7	6	6	6
Number of coating units	2	1	1	1
Maximum sheet size	720mm×1,020mm	720mm×1,020mm	720mm×1,020mm	600 x 740mm
Minimum sheet size	340mm×480mm	340mm×480mm	340mm×480mm	210 x 350mm
Maximum printing area	710mm×1,020mm	710mm×1,020mm	710mm×1,020mm	585 x 730 mm
Printing plate size	790mm×1,030mm	790mm×1,030mm	790mm×1,030mm	660 x 745 mm
Maximum speed	15000 Sheets/hour	16,500 Sheets/hour	15000 Sheets/hour	15000 Sheets/hour
Minimum Speed	3000 Sheets/hour	3000 Sheets/hour	3000 Sheets/hour	3000 Sheets/hour

The data for this research was collected from monthly wastage sheets and wastage analysis report and further subjected to appropriate statistical tool to calculate the percentage wastage due to printing machine issues, lamination, corrugation, manual die punching, auto die punching, stripping, pasting and miscellaneous (Folding, Blister, Planning Waste). The data was further segmented and analysed to identify the major defects contributing to wastage for specific jobs in the months of February to May. Using the collected data, the monthly percentage wastage was calculated for each type of waste based on the following formula;

$$Percentage\ Wastage = \left(\frac{W}{T}\right) \times 100 \qquad \ldots (1)$$

Where,

W = Waste (number of sheets)

T = Total Quantity (number of sheets including waste and good sheets)

4. Data Collection & Analysis

The data was collected from the monthly wastage report from the different sections. Each process causes some wastage due to various reasons such as shade variation (design correction, dampening problem, correct mixture of ink (pantone), machine problem (rollers problems), board tone change, scum (blanket cleaning, dampening setting), set off (ink drying problem, improper ink-water balance), hickeys (dust and dirt particles on the plate or blanket), punching out (side pin and gripper problem), lamination wrinkle (board waviness problem & film problem) etc. Table 3. Outlines the waste in different sections.

Table 3. Waste in different sections

Process Used	February	March	April	May	Total Waste
Printing	351294	265091	223924	228491	1068800
Lamination	38104	18533	5875	11385	73897
Corrugation	1546	3496	180	3146	8368
Manual Die Punching	800	7781	963	1712	11256
Auto Die Punching	66206	19521	23402	26543	135672
Stripping	29831	7687	4134	3410	45062
Pasting	23959	16115	15973	15235	71282
Miscellaneous*	780	891	698	456	2825

**(Folding, Blister, Planning Waste)*

In the Month of February, a total quantity of 15,464,196 prints were printed. The waste breakdown by different processes demonstrates that printing has the highest waste at 2.27%. Lamination (0.25%) and auto die punching (0.43%) also show notable waste levels, while corrugation, manual die punching, and miscellaneous processes have minimal waste (0.01%). Stripping and pasting resulted in moderate waste levels at 0.19% and 0.15%, respectively. The data clearly indicate that the printing process is the significant area for potential waste reduction. Figure 3. displays the percentage waste in different processes in the Month of February.

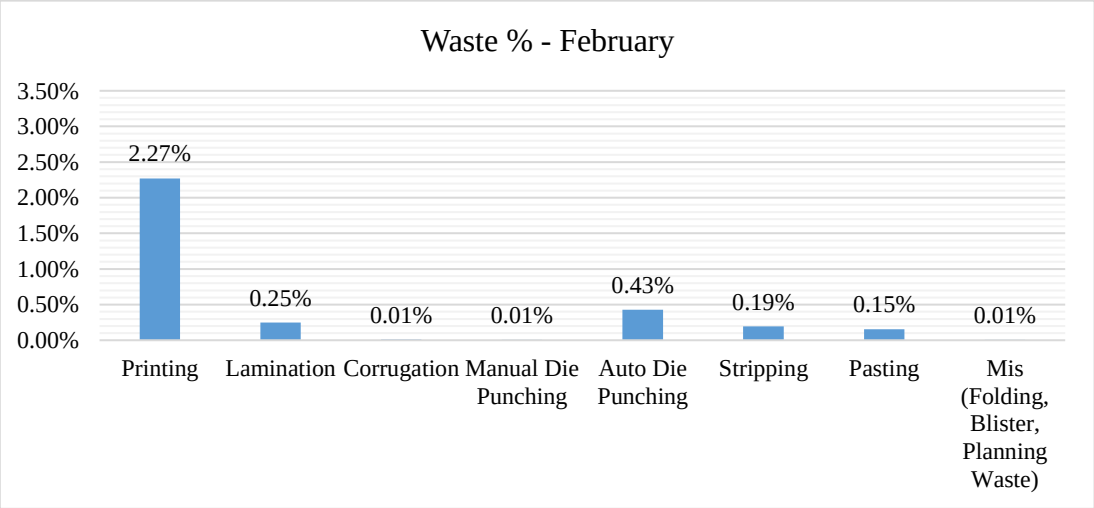

Figure 3. Percentage waste in month of February

In March, the data reveals the following percentage of waste across various processes: printing exhibited the highest waste at 3.01%, indicating a substantial amount of waste. Lamination had a relatively low waste percentage of 0.21% while in corrugation the waste percentage was 0.04%. Manual die punching showed a waste percentage of 0.09%, higher than some other processes but still relatively low. Auto die punching waste was at 0.22%. Stripping had a waste percentage of 0.09%, similar to manual die punching. Pasting resulted in a waste

percentage of 0.18%. Miscellaneous (Folding, Blister, Planning Waste) waste had a minimal percentage of 0.01%. Figure 4. displays the percentage waste in different processes in the month of March.

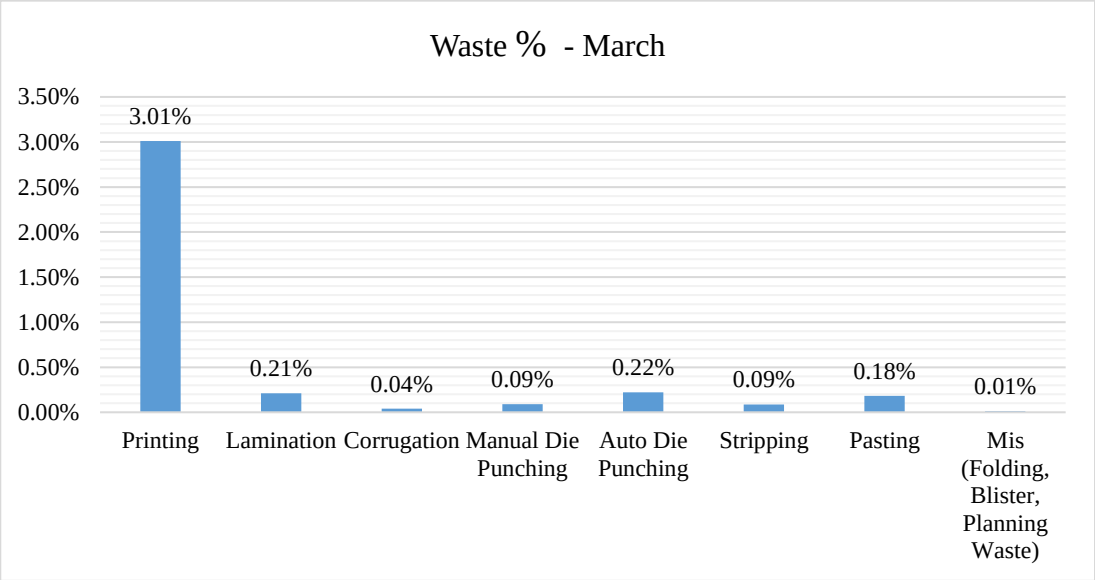

Figure 4 Percentage waste in month of March

In April, the waste percentages across various processes were as follows: printing had a waste percentage of 2.18%, showing an improvement compared to March but still a significant amount of waste occurred in printing. Lamination exhibited a substantial reduction in waste comprising 0.06% of the total waste. Manual die punching also maintained a low waste percentage of 0.01%, similar to previous months. Auto die punching had a slight increase in waste to 0.23%. Stripping waste was significantly reduced to 0.04%, while pasting waste remained consistent at 0.16% of the total waste. Miscellaneous (Folding, Blister, Planning Waste) processes resulted in a low waste percentage of 0.01%. Figure 5. displays the percentage waste in different processes in the month of April.

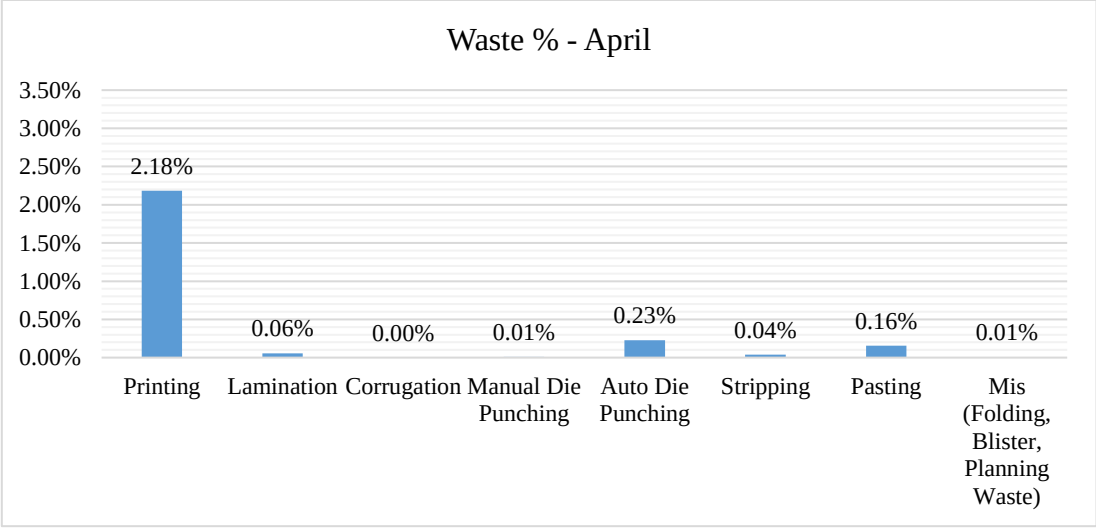

Figure 5. Percentage waste in month of April

In May, the waste percentages across various processes were as follows: printing section was the largest contributor to waste, which represents 2.44% of the total waste, slightly higher than in April. Lamination exhibited in 0.06% of the total waste. Manual die punching also maintained a low waste percentage of 0.02%, similar to previous months. Auto die punching had 0.28% waste of the total waste. Stripping and pasting waste was 0.04% and 0.16%, respectively. Figure 5. displays the percentage waste in different processes in the month of April.

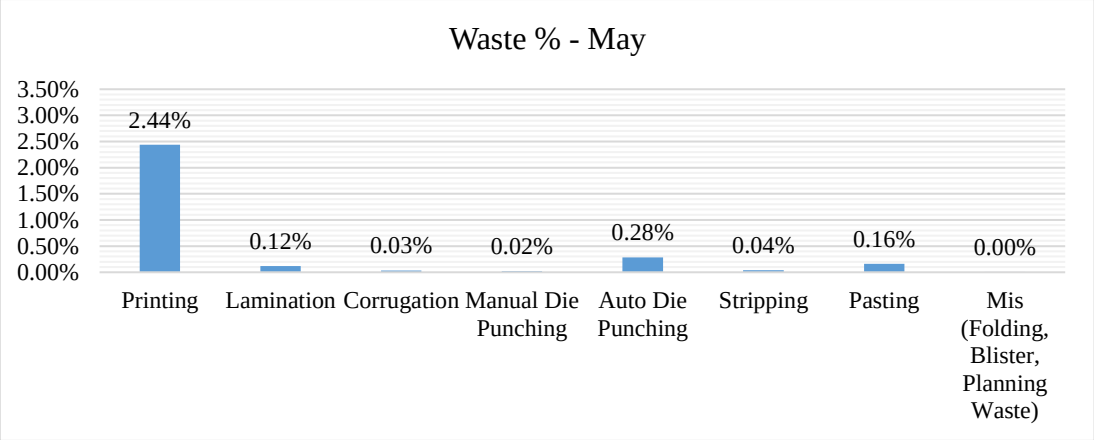

Figure 6. Percentage waste in month of May

The cumulative printing waste of four months amounts to 4,390,4031, with a cumulative percentage of 2.43%. The data shows that the auto die punching waste percentage is 0.31%, lamination waste percentage is 0.17%, pasting 0.16% and stripping 0.10%. Most processes exhibit relatively low waste percentages, with values predominantly falling between 0.01% and 0.31%. This indicates a general trend towards minimal waste, though the highest percentages suggest areas where further waste reduction strategies could be beneficial. Figure 7. displays the cumulative percentage waste in different processes.

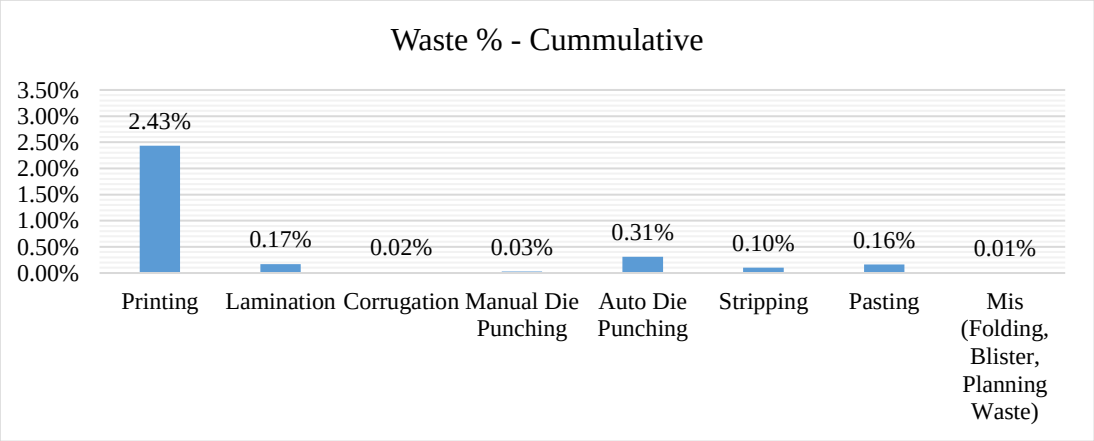

Figure 7. Cumulative Percentage Waste

6.Result and Discussions

The cumulative data indicates a total waste of 4,390,4031 in the span of four months, corresponding to a waste percentage of 2.43% during printing. A significant portion of this waste arises from printing section, which account for 2.43% of the total waste. The common causes of waste in printing include shade variation due to design corrections, dampening problems, incorrect mixture of ink, machine issues (such as roller problems), and board tone changes. Other sources of waste include auto die punching (0.31%), caused by side pin and gripper issues, and lamination processes (0.17%), which are impacted by board waviness and film problems.

To address these issues, a comprehensive approach to identifying and analysing causes and sources of waste in various section is very important. This involves examining the entire production process to pinpoint material waste, energy inefficiencies, time losses, and defects. It is recommended to adopt process standard to meet the targets. Implementing lean manufacturing principles will streamline processes, eliminate non-value-added activities, and optimize resource utilization. Additionally, providing employees with training on lean methodologies and engaging them in waste reduction initiatives will be essential for sustained success.

Quality control measures must be adopted to detect and prevent defects early in the production process, thereby reducing rework, scrap, and resource wastage. Continuous monitoring and measurement of key performance indicators related to waste reduction will help in identifying areas for further improvement.

7. Conclusion

Wastage in production can arise from various issues that affect the quality and consistency of the printing process. Various print problems cause waste during printing. Consistency in offset printing is largely based on the adoption of process standard and maintaining the proper ink-water balance. Shade variation is a common cause of wastage and can result from several factors, including improper machine settings, dampening problems, incorrect mixture of ink (Pantone), machine issues such as roller problems, and changes in board tone. Scumming, another cause of wastage, can occur due to inadequate blanket cleaning and improper dampening settings. Set off, where ink transfers from one sheet to another due to insufficient drying, is often caused by ink drying problems.

Hickeys, which are white spots caused by dust on the board during printing, also contribute to wastage. Punching out issues, which involve problems with side pins and grippers, can lead to misaligned or poorly cut sheets. Lamination wrinkles, resulting from board waviness and film problems, further contribute to production wastage.

References

[1] Baumann, H., & Timpe, H. J. (1994). Chemical Aspects of Offset Printing. Journal für Praktische Chemie/Chemiker-Zeitung, 336(5), 377-389.
[2] Boora, S., & Batra, V. (2017). An Analytical Study of the Solid and Hazardous Waste Management in Paper/Paperboard Packaging Industry. International Journal of Science, Engineering and Computer Technology, 7(1), 54-57.
[3] Boora, S., & Batra, V. (2017). Study and Analysis of Solid and Hazardous Waste Generation in Paper/Paper Board Packaging Industry. International Journal of Science, Engineering and Computer Technology, 7(2), 128-132.
[4] Buckwalter, C. (2006). Integrating Systems in the Print Production Workflow: Aspects of Implementing JDF (Doctoral dissertation, Institutionen för teknik och naturvetenskap).
[5] Chea, A. C. (2008). Causes and Sources of Waste in the Printing Industry in Ghana: A Study of Printing Houses in the Cities of Accra and Kumasi. International Business Research, 1(3), 22-31.
[6] DeJidas, L. P., & Destree, T. M. (2005). Sheetfed Offset Press Operating. Graphic Arts Tech Fo.
[7] Franchetti, M. J. (2009). Solid Waste Analysis and Minimization. New York: McGrawHill.
[8] Kipphan, H 2001 "Handbook of Printed Media" Springer-Verlag, Berlin, Germany
[9] Korytkowski, P., Olejnik-Krugly, A., & Zaikin, O. (2009). A Framework for a Quality Assurance in Offset Printing. IFAC Proceedings Volumes, 42(4), 1875-1880.
[10] Lundberg, M., & Wallin, C. M. (2016). Reducing Paper Waste to Improve Resource Efficiency at a Swedish Printing and Packaging Company.
[11] Lundström, J., Verikas, A., Tullander, E., & Larsson, B. (2013). Assessing, Exploring, and Monitoring Quality of Offset Colour Prints. Measurement, 46(4), 1427-1441.
[12] Mehra, S., & Baral, A. K. (2023). Identification and Critical Analysis of Various Components of Press Set-Up Time in Sheet Fed Offset Presses with Different Levels of Automation and their Possible Impact on Print Productivity & Resource Savings. Journal of Southwest Jiaotong University, Vol 58, No 1 (2023).
[13] Srl. (20125). Quality Control in the Printing Industry. In Srl – via Zuccoli 18, 20125 MILANO. https://cofomegra.it/download/Densitometer/QUALITY_CONTROLS.pdf
[14] Varma. (2012, July 25). The Role of Paper in the Production Process - Graphic Arts Media. Retrieved November 8, 2022, from https://www.graphicartsmedia.com/magazine-stand/the-role-of-paper-in-the-production-process/