Nanotechnology Perceptions
ISSN 1660-6795
www.nano-ntp.com

Analysing Colour Shift effect of various Lamination Techniques on Coated Media using Offset Printing

Amit Sharma[1], Prof. Ambrish Pandey[2], Prof. Rajendrakumar Anayath[3]

[1] PhD Scholar, Department of Printing Technology, Guru Jambheshwar University of Science & Technology, Hisar - 125001 (Haryana) INDIA
[2] Supervisor, Professor, Department of Printing Technology, Guru Jambheshwar University of Science & Technology, Hisar - 125001 (Haryana) INDIA
[3] Co-Supervisor, Former Vice-Chancellor, DCRUST, Murthal (Haryana) INDIA

ABSTRACT

Colour accuracy is the inevitability in every printing industry. Even minor deviations may impact severely in terms of print quality. Offset printing is widely used printing technique and also known for high quality production and efficiency also relies on precise colour reproduction in order to meet print quality expectations as per industry standards. Lamination and other post printing operations are common for embellishment to improve visibility aspects. In contrast, lamination technique cause colour shift in terms of colorimetric attributes which alters the appearance of printed colour significantly. This research is an attempt to analyze colour shift effect due to various lamination techniques on coated media printed by using offset printing. This research will explore the relationship between colour shift and lamination techniques while offset printing.

Keywords: Colour Shift, Coated Media, Offset Printing, Lamination, Gloss, High Gloss, Matt Lamination, Silk Lamination

Introduction

Offset printing is an indirect method of printing which underlies on the principle ‘Oil and Water do not mix with each other’ (Kipphan, 2001). During printing image area is ink-accepting and non-image area water-receptive (NIIR Board of Consultants & Engineers, 2017). Ink is applied on image area by inking unit and dampening solution is applied on image carrier by dampening unit. Then inked image in transferred on the blanket(rubber) cylinder which is further on to the substrate using suitable impression pressure by impression cylinder. Fig. 1 depicts working principle of Offset printing.

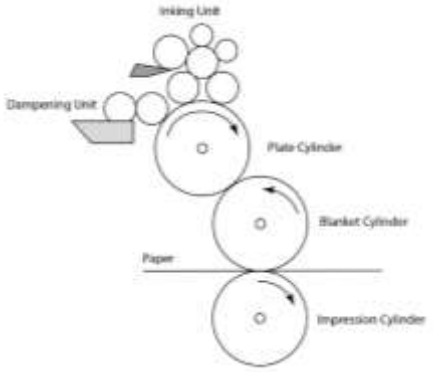

Fig. 1: Offset Printing Principle

Color accuracy and consistency (Nunoo et al., 2019) are critical in the printing industry, where even slight deviations can impact the quality (Elliot & Cockburn, 2010) and marketability of printed materials. Colour accuracy is a critical performance specification of a printing device (Yedid-am & Il, 2011) which is need of hour these days. But finishing operations which includes varnishing, coating and lamination (Majnarić et al., 2012) can significantly alter the print appearance.

Colour shift is the colour difference commonly evaluated in terms of delta E (ΔE) using CIE L*a*b* Colour model (Sotiropoulou & Chryssoulakis, 2000). CIE L*a*b* colour space (Jangra et al., 2023) is composed of three dimensions which includes L* (Lightness/Darkness), a* (Green-Red axis) and b* (Blue-Yellow axis) (Cinko & Becerir, 2019).

Lamination is a post-press finishing technique (Stiene et al., 2019) commonly used to protect any printed materials. In addition to this it enhances the aesthetic appeal of printed material. It also increases not only durability, but also the resistance of print media to various environmental aspects. Despite of so many advantages, lamination causes colour shift of printed media in terms of visual perceptions (Stiene et al., 2019).

Objectives of Study

Print enhancement is very crucial aspect for attractive and innovative print applications for which numerous laminations are made on printed substrates are used for enhancing print quality now-a-days. But every lamination technique has its unique effect on print enhancement in terms of colour shift or print quality parameter. The key objective of this study is to analyze the phenomenon of colour shift due to various lamination techniques on Coated Paper media printed using offset printing.

Research Methodology

For carrying out the study of Colour Shift effect of various Lamination Techniques on Coated Media using Offset Printing, first and foremost a Master Test Chart was developed by incorporating technical parameter as per printing standard. The flowchart for executing the research process is as below:

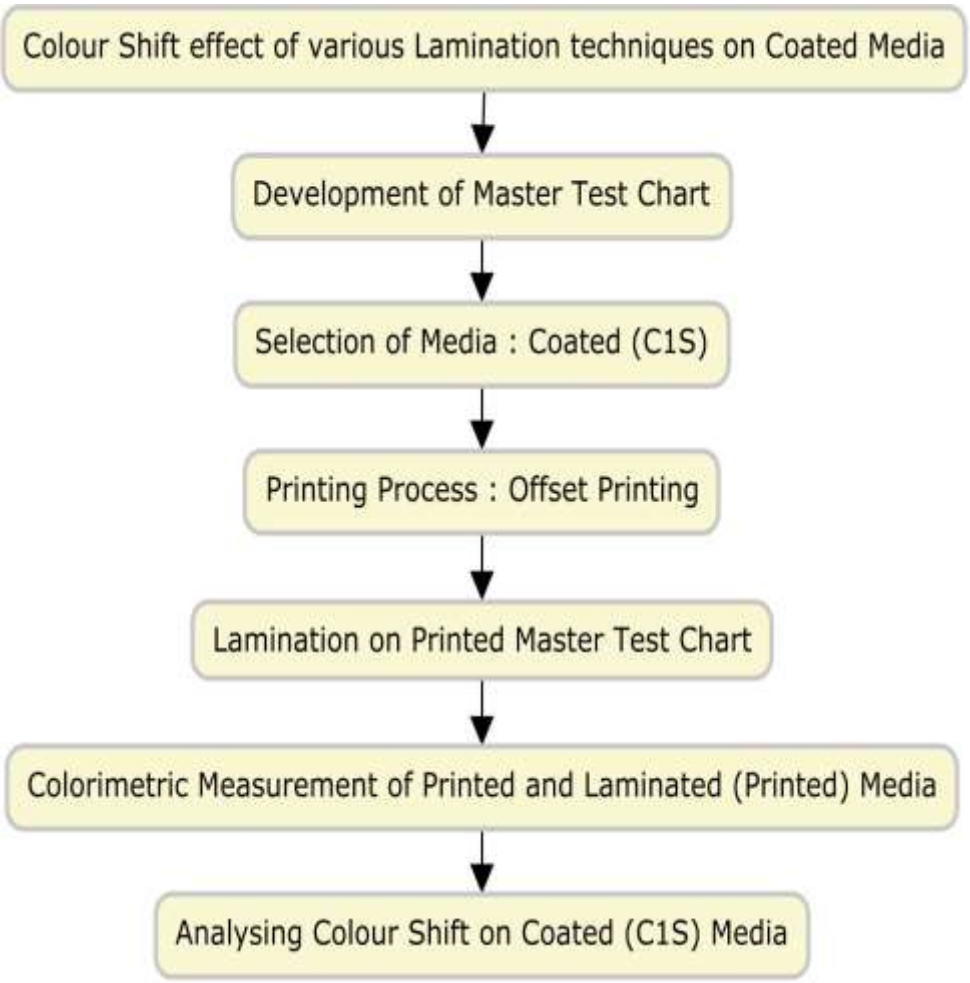

Fig. 2: Flowchart for attainment of research objective

i. Master Test Chart: Suitable master Test Chart was developed by incorporating various elements keeping in view of research objective
ii. Media Selection: Coated paper media (C1S) was taken into consideration for research work.
iii. Process of Printing: Offset printing process was used for printing for this study under standard press room condition.
iv. Lamination Process: After printing sample selection was made for carrying out various lamination process post printing process.
v. Colorimetric Measurement: Pre-operation (without lamination) and post operation (lamination) spectrophotometer was used for capturing of data of selected printed samples.

Data Analysis

In order to analyze colour shift effect of various lamination techniques (fig. 3) on Coated Media using Offset Printing process, colorimetric aspect colour difference (ΔE Value) was taken into consideration. The analysis of data (number of sample sheets measured on X-axis and their respective colorimetric value i.e. ΔE Value on Y-axis) is depicted as below:

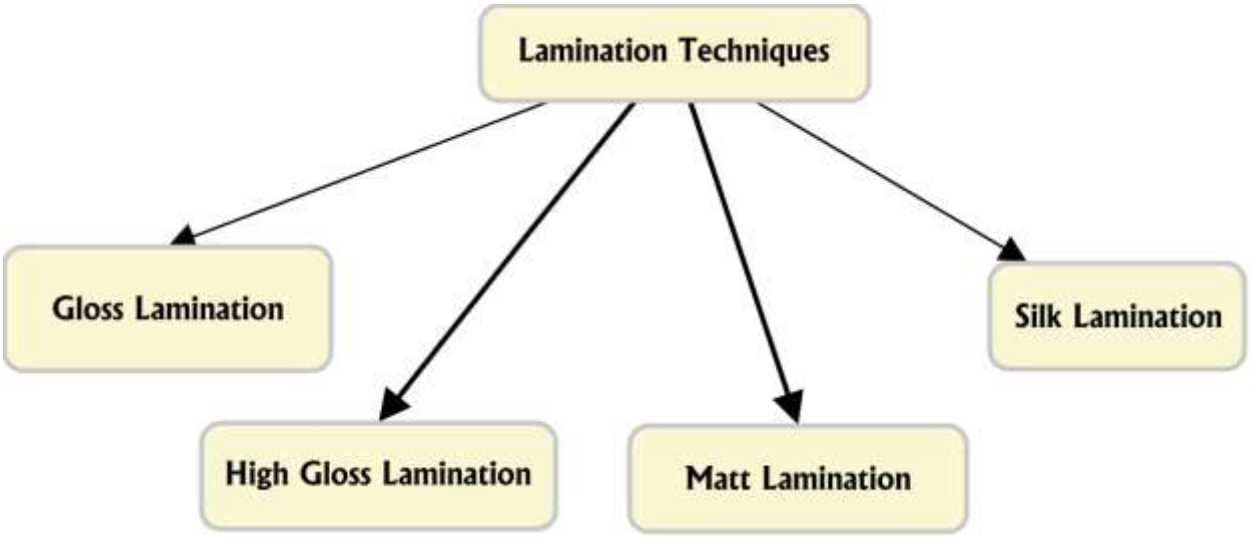

Fig. 3: Lamination Techniques

1. **Colour Shift due to Gloss Lamination:** The colour shift (ΔE Value) of process colour i.e. Cyan, Magenta, Yellow and Black during Offset Printing on Coated Media due to Gloss Lamination is presented in fig. 4 (a, b, c and d respectively).

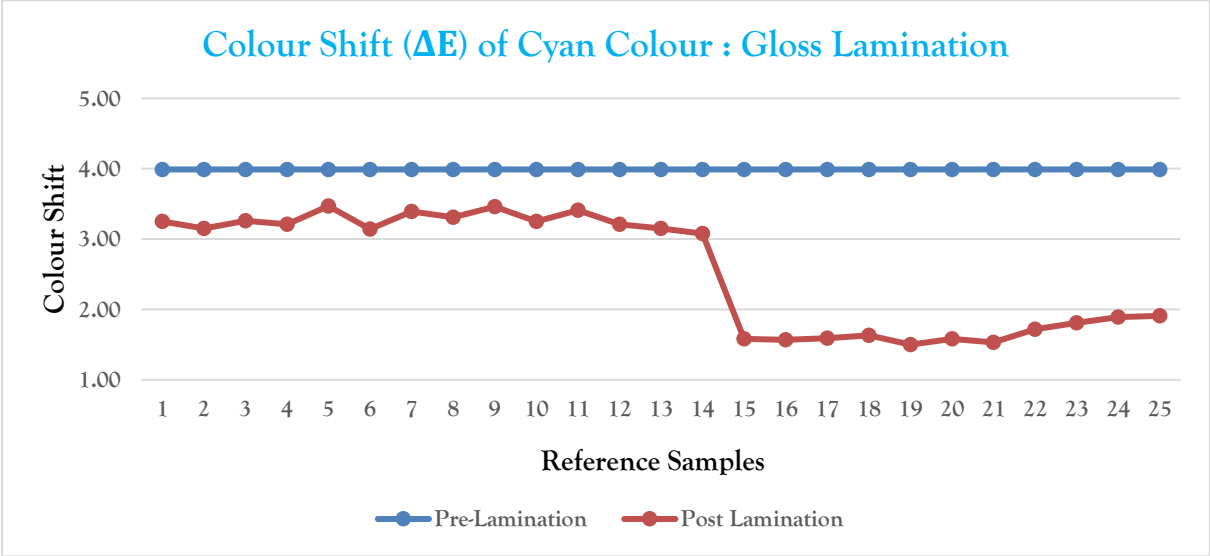

Fig. 4 (a): Colour Shift (ΔE) of Cyan Colour after Gloss Lamination

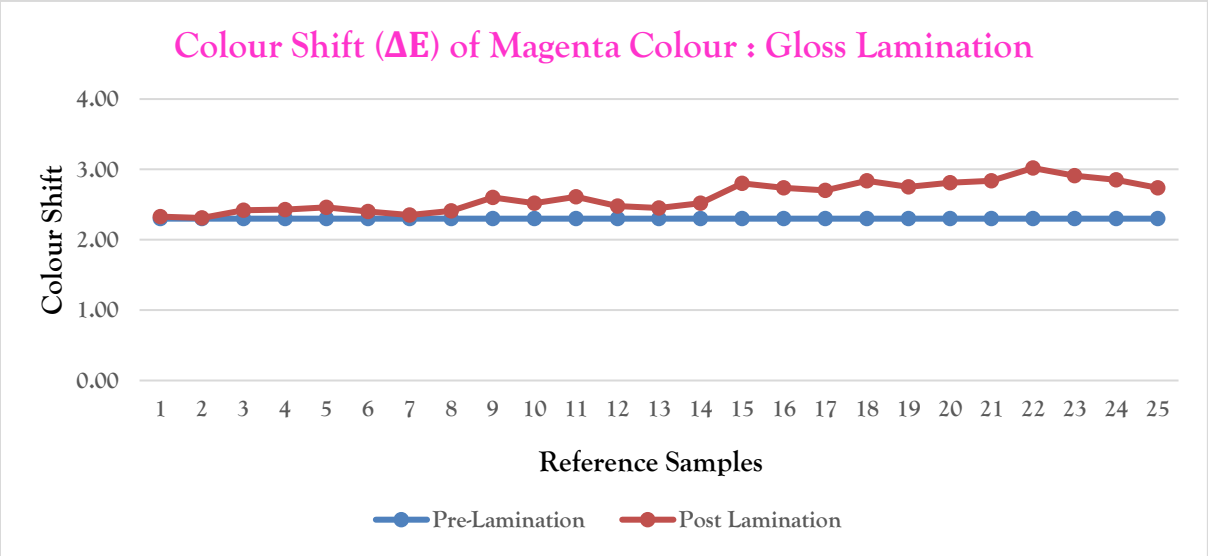

Fig. 4 (b): Colour Shift (ΔE) of Magenta Colour after Gloss Lamination

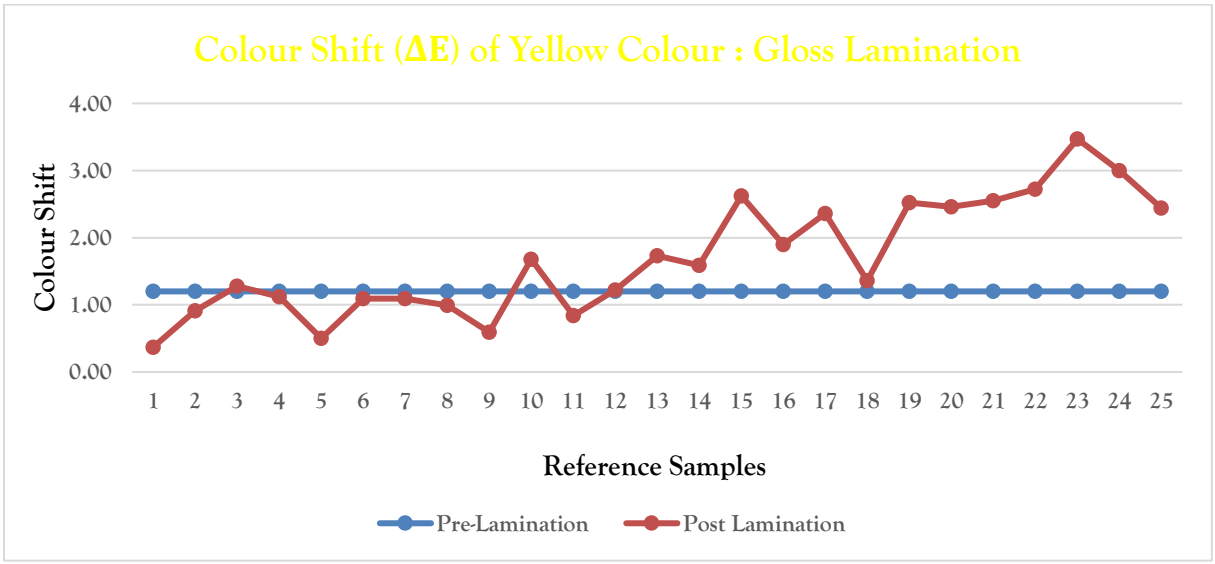

Fig. 4 (c): Colour Shift (ΔE) of Yellow Colour after Gloss Lamination

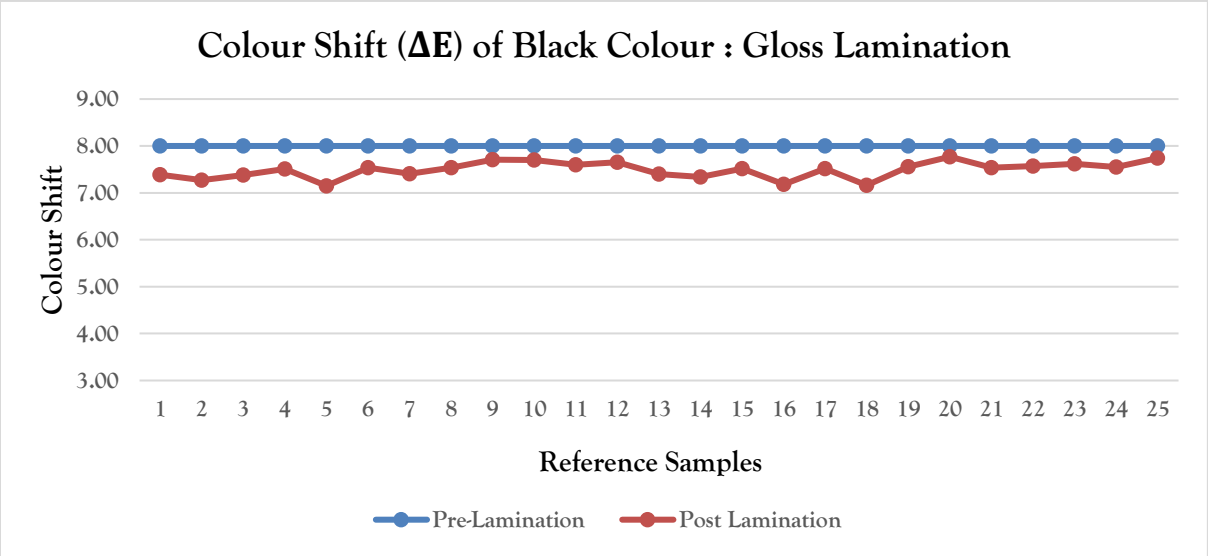

Fig. 4(d): Colour Shift (ΔE) of Black Colour after Gloss Lamination

The results of Colour Shift (ΔE value) of Cyan colour due to gloss lamination on coated paper media using offset printing are depicted in fig. 4 (a). The findings depicted that the ΔE Value was consistent at 3.99 on coated paper media without gloss lamination. On the other hand, the range of colour shift (ΔE Value) of Cyan was observed 1.50 – 3.47 on coated paper media after gloss lamination. Fig 4 (b) depicted that the pre-operation (without lamination) ΔE Value was found 2.30 on coated paper media while post operation (gloss lamination) ΔE Value was found ranging from 2.31 to 3.02 for magenta colour while printed with offset printing. The initial without gloss lamination, colour shift (ΔE Value) of yellow colour was recorded 1.20, while after gloss lamination the variation was observed from 0.37 to 3.47 on coated paper media printed using offset printing as depicted in fig. 4 (c). The colour shift (ΔE Value) for black colour was noticed 8.00, on the other hand the variation was found in the range of 7.15 to 7.77 on coated media printed using offset printing after gloss lamination as shown in fig. 4 (d).

2. **Colour Shift due to High Gloss Lamination**: The colour shift effect due to high gloss lamination techniques on Coated Media using Offset Printing process in terms of colour shift (ΔE Value) of process colour i.e. Cyan, Magenta, Yellow and Black during printing is presented in fig. 5 (a, b, c and d respectively).

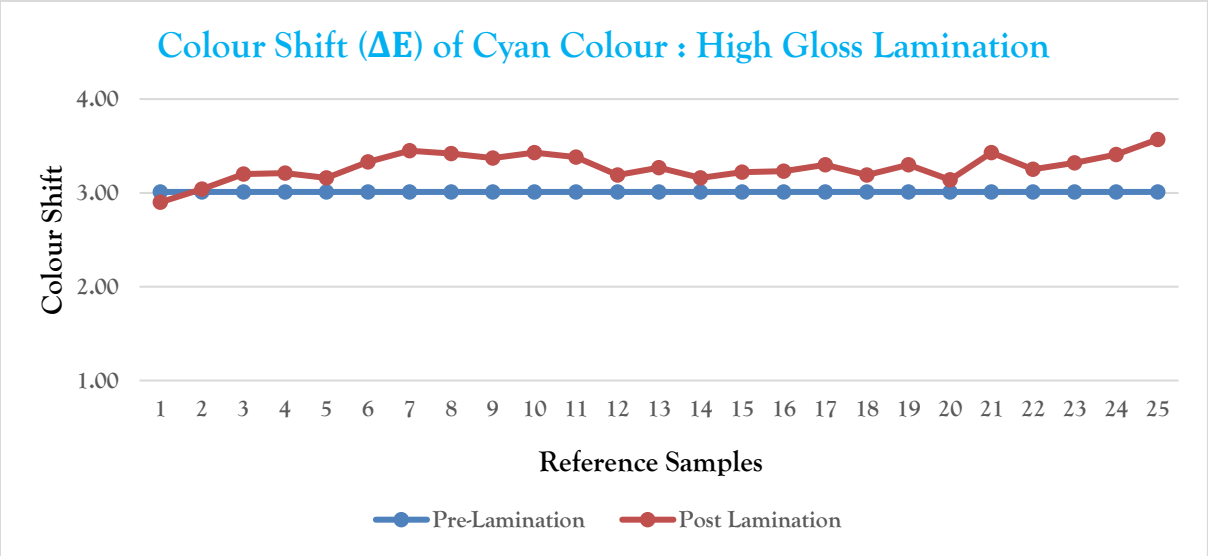

Fig. 5 (a): Colour Shift (ΔE) of Cyan Colour after High Gloss Lamination

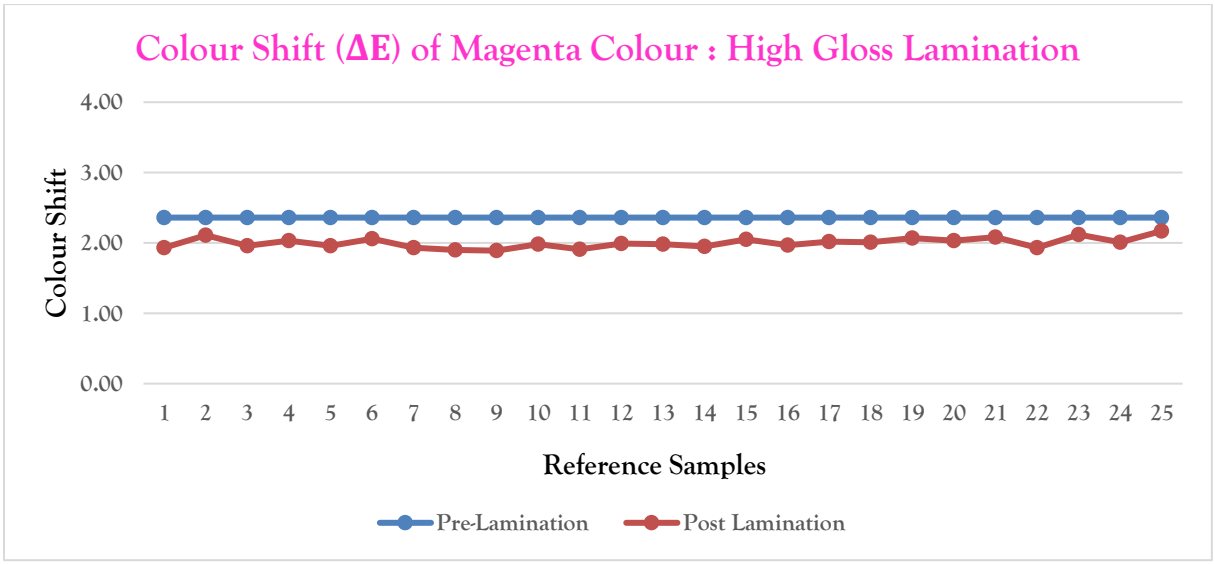

Fig. 5 (b): Colour Shift (ΔE) of Magenta Colour after High Gloss Lamination

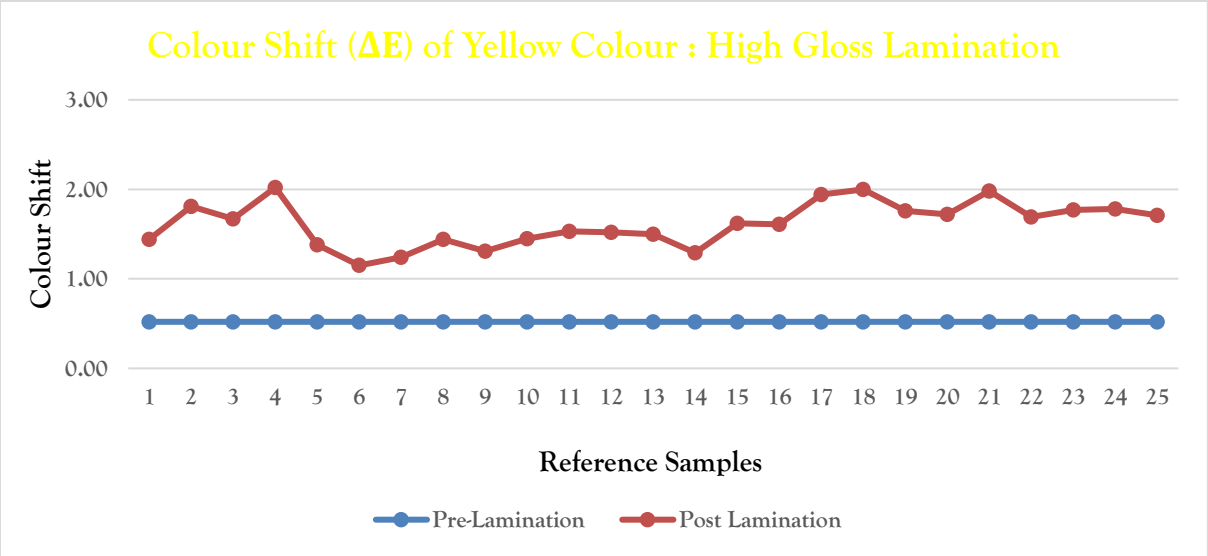

Fig. 5 (c): Colour Shift (ΔE) of Yellow Colour after High Gloss Lamination

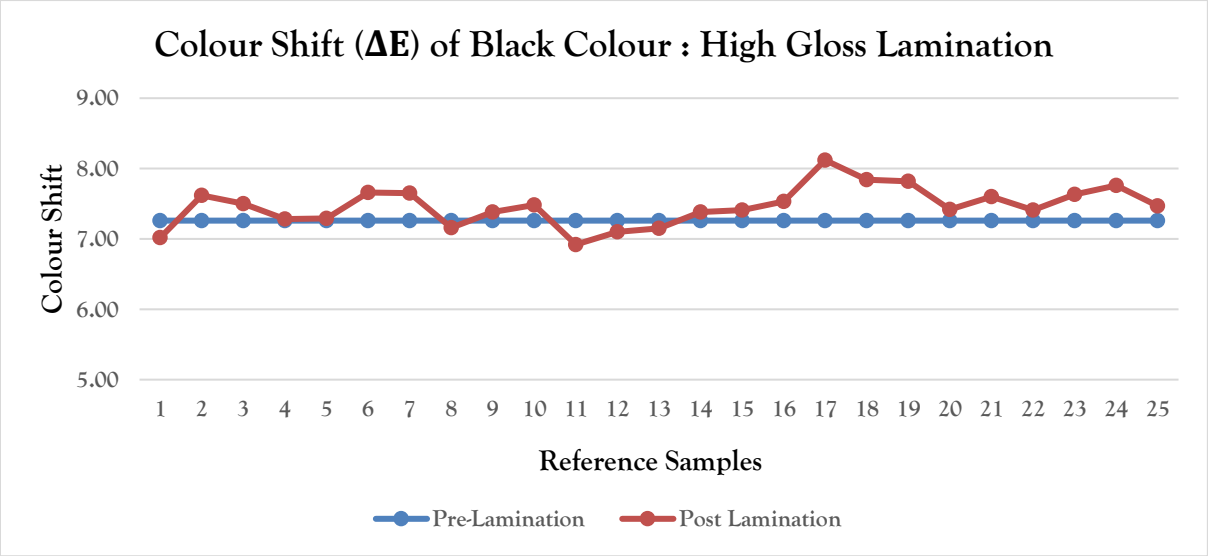

Fig. 5 (d): Colour Shift (ΔE) of Black Colour after High Gloss Lamination

The findings of colour shift (ΔE Value) of Cyan on coated paper media during offset printing due to high gloss lamination are represented in fig. 5 (a). During observation it was found that the range of colour shift on coated paper media without high gloss lamination was consistent at 3.01. After high gloss lamination on the printed Coated Paper Media, the range of colour shift (ΔE Value) of Cyan were found in the range 2.90 - 3.57. The initial without high gloss lamination, colour shift (ΔE Value) of magenta colour was recorded 2.36, while after gloss lamination the variation was observed from 1.89 to 2.17 on coated paper media printed using offset printing as depicted in fig. 5 (b). The colour shift (ΔE Value) for yellow colour was noticed 0.52, on the other hand the variation was found in the range of 1.15 to 2.02 on coated media printed using offset printing after high gloss lamination as shown in fig. 5 (c). Fig 5 (d) depicted that the pre-operation (without lamination) ΔE Value was found 7.26 on coated paper media while

post operation (high gloss lamination) ΔE Value was found ranging from 6.92 to 8.12 for black colour while printed with offset printing.

3. **Colour Shift due to Matt Lamination:** The variation of process colour i.e. Cyan, Magenta, Yellow and Black in terms of colour shift (ΔE Value) on Coated Paper Media using Offset Printing due to Silk Lamination is presented in fig. 6 (a, b, c and d respectively).

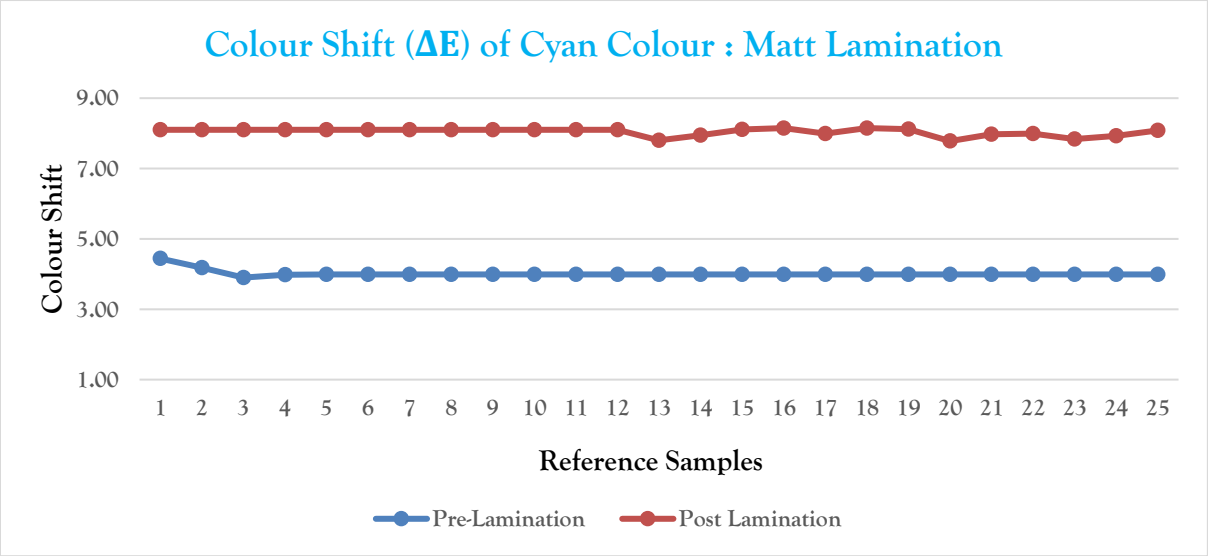

Fig. 6 (a): Colour Shift (ΔE) of Cyan Colour after Matt Lamination

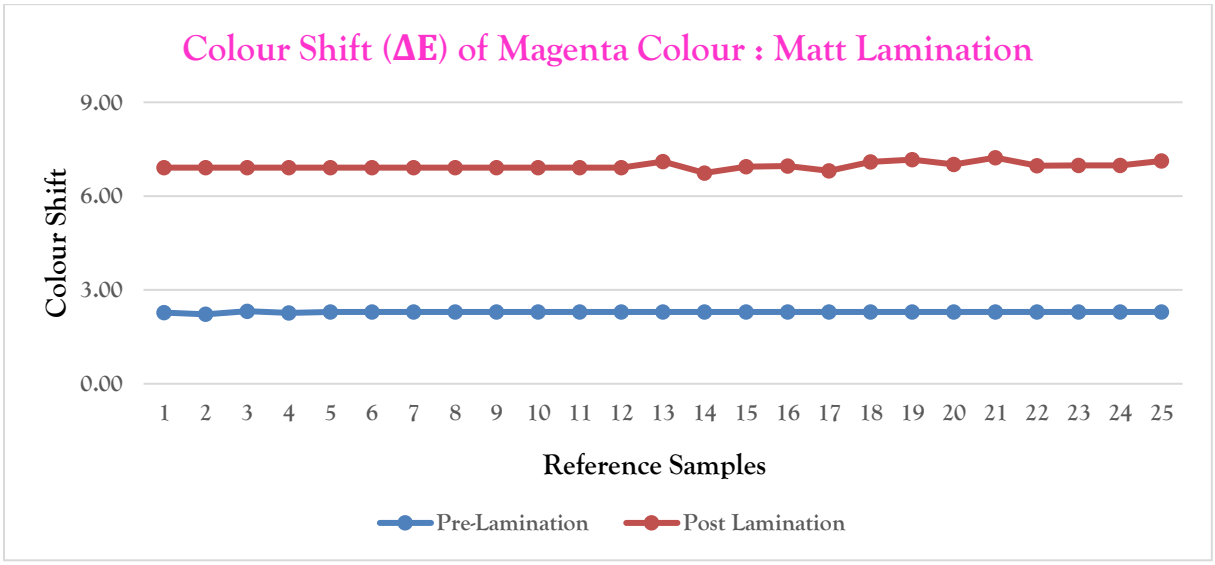

Fig. 6 (b): Colour Shift (ΔE) of Magenta Colour after Matt Lamination

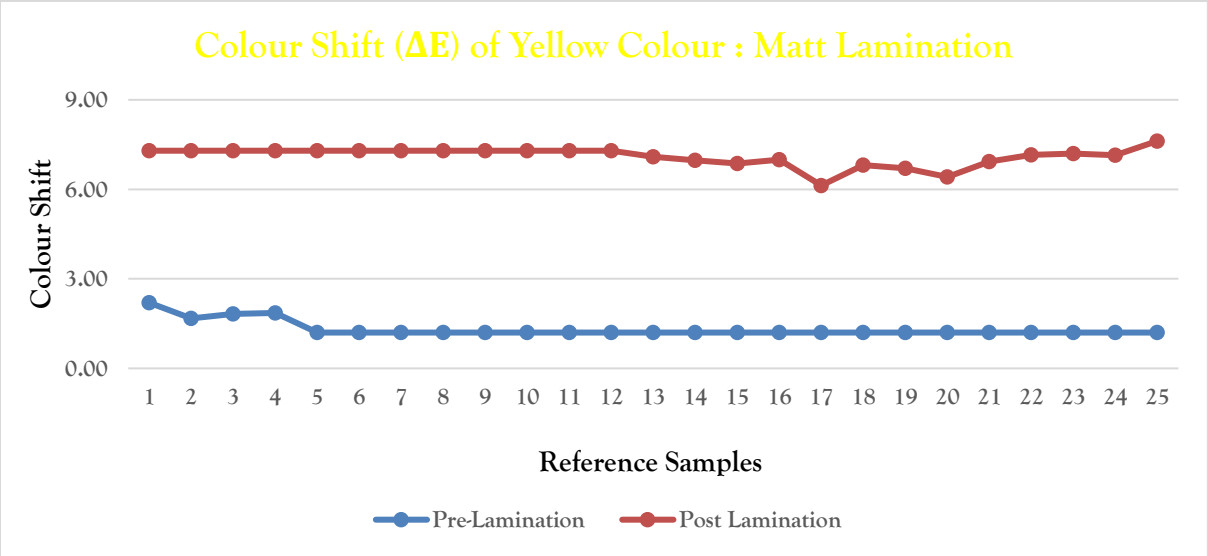

Fig. 6 (c): Colour Shift (ΔE) of Yellow Colour after Matt Lamination

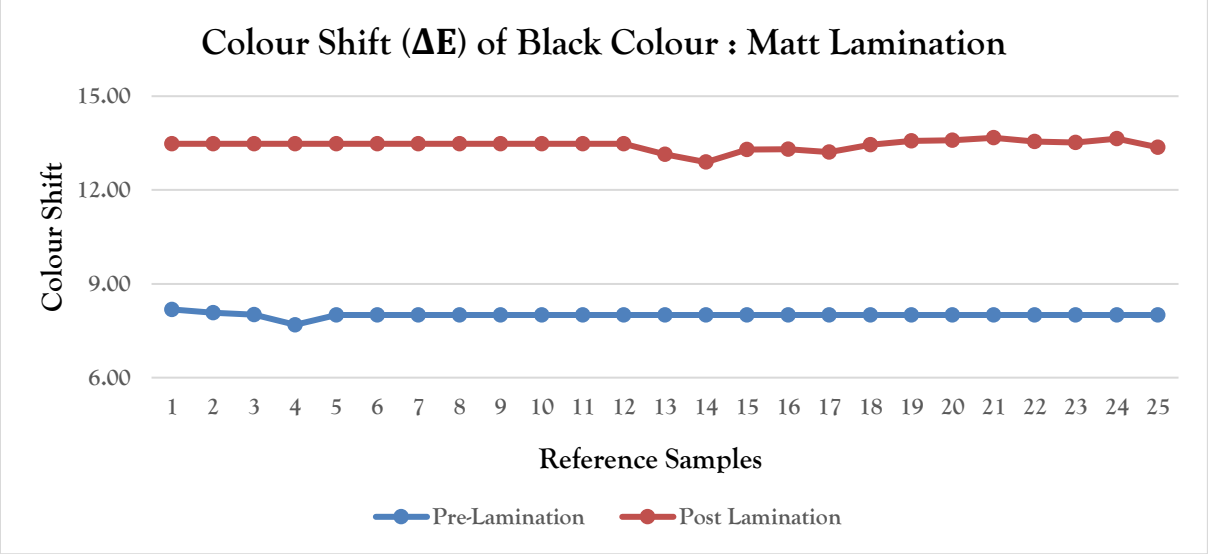

Fig. 6 (d): Colour Shift (ΔE) of Black Colour after Matt Lamination

Fig 6 (a) depicted the findings of Colour Shift (ΔE value) of Cyan colour on coated paper media during offset printing due to matt lamination. During observation it was found that the pre-operation (without lamination) ΔE Value was found 3.90 to 4.44 on coated paper media while post operation (matt lamination) ΔE Value was found ranging from 7.78 to 8.15 for cyan colour while printed with offset printing.

The findings of colour shift of magenta colour depicted that the ΔE Value was found in range of 2.22 to 2.32 on coated paper media without matt lamination. On the other hand, the range of colour shift (ΔE Value) of magenta was observed 6.74 to 7.23 on coated paper media after gloss lamination represented in fig. 6 (b).

The initial without high gloss lamination, colour shift (ΔE Value) of yellow colour was recorded from 1.20 to 2.20, while after silk lamination the variation was observed from 6.13 to 7.62 on coated paper media printed using offset printing as depicted in fig. 6 (c).

The colour shift (ΔE Value) for black colour was observed in range from 7.69 to 8.18, on the other hand the variation was found in the range of 12.89 to 13.67 as shown in fig. 6 (d) on coated media printed using offset printing after silk lamination.

4. **Colour Shift due to Silk Lamination**: The colour shift effect in terms of colour shift (ΔE Value) of process colour i.e. Cyan, Magenta, Yellow and Black during printing due to silk lamination techniques on Coated Media using Offset Printing process is presented in fig. 7 (a, b, c and d respectively).

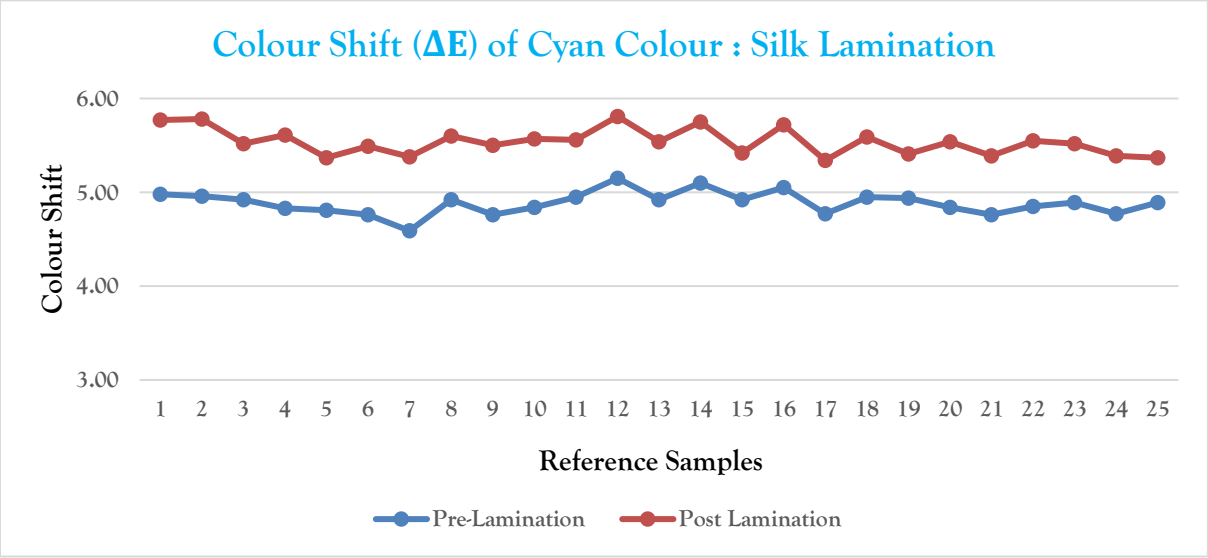

Fig. 7 (a): Colour Shift (ΔE) of Cyan Colour after Silk Lamination

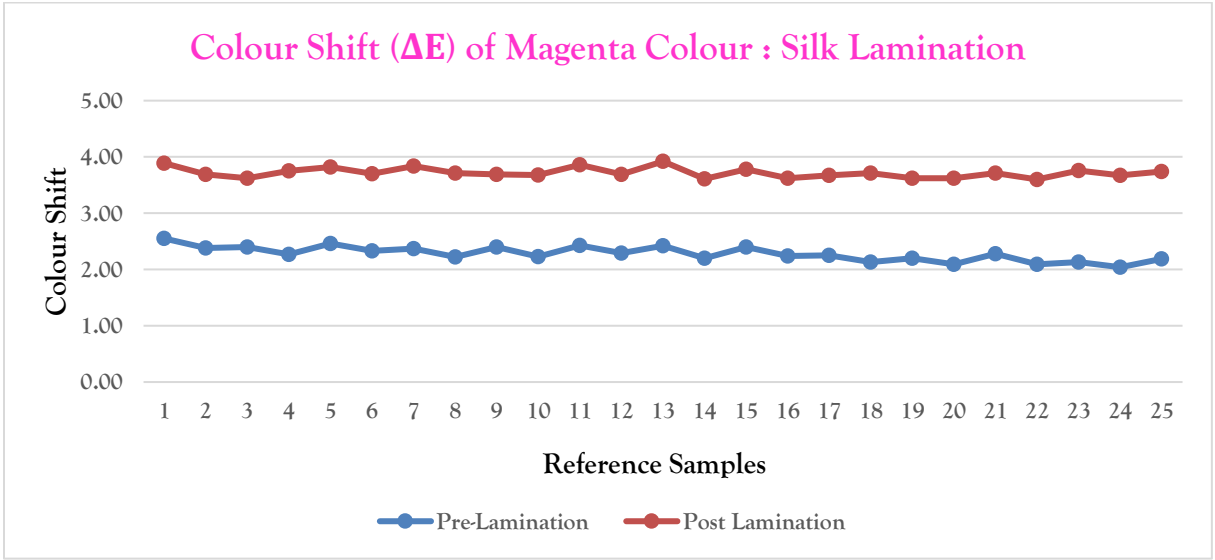

Fig. 7 (b): Colour Shift (ΔE) of Magenta Colour after Silk Lamination

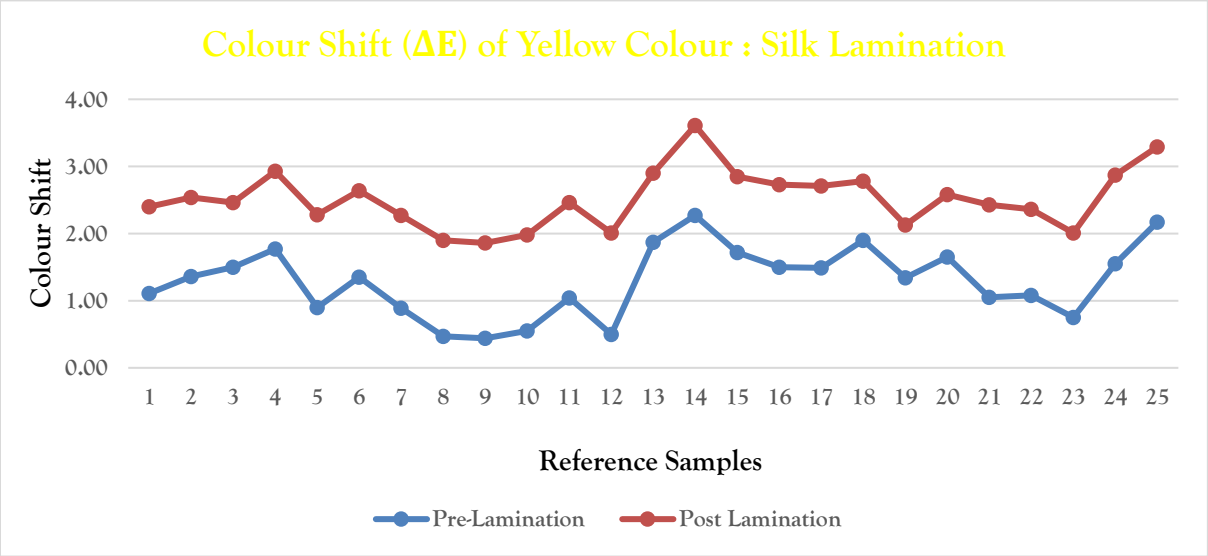

Fig. 7 (c): Colour Shift (ΔE) of Yellow Colour after Silk Lamination

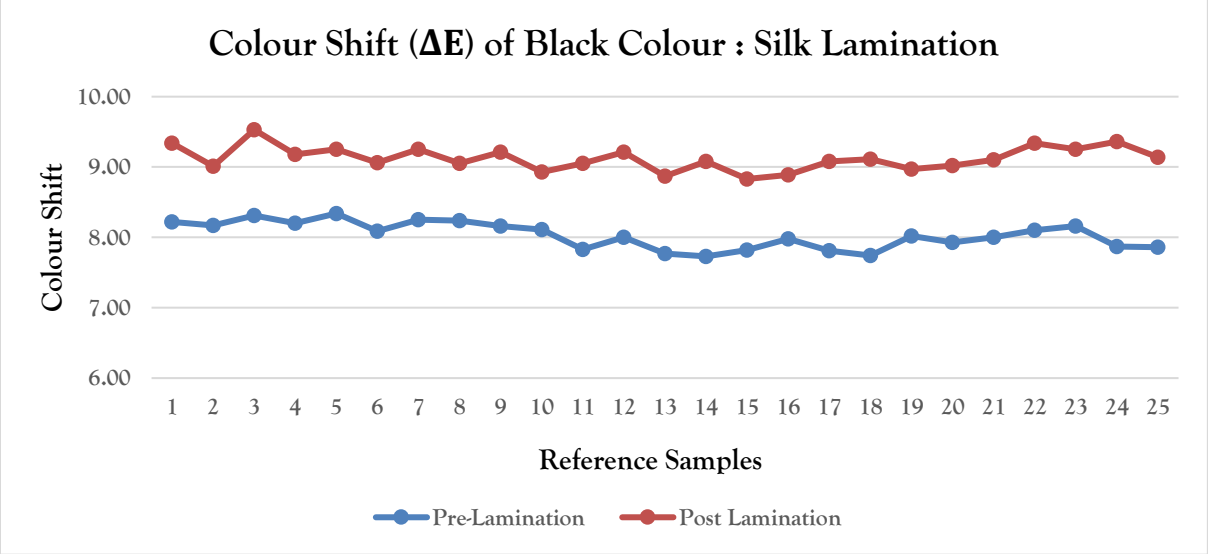

Fig. 7 (d): Colour Shift (ΔE) of Black Colour after Silk Lamination

The results of the findings for colour shift (ΔE Value) of Cyan colour on coated paper media while offset printing are expressed in fig. 7 (a). During observation the range of colour shift (ΔE Value) of Cyan colour was recorded from 4.59 to .15 on Coated Paper Media without Silk lamination. While the range of colour shift (ΔE Value) of Cyan after Silk lamination was observed in the range from 5.34 to 5.81.

The colour shift (ΔE Value) for magenta colour was noticed in range of 2.04 to 2.55, on the other hand the variation was found in the range of 3.60 to 3.92 on coated media printed using offset printing after silk lamination as shown in fig. 7 (b).

Fig 7 (c) depicted that the pre-operation (without lamination) ΔE Value was found in range of 0.44 to 2.27 on coated paper media while post operation (silk lamination) ΔE Value was found ranging from 1.86 to 3.61 for yellow colour while printed with offset printing.

The initial without silk lamination, colour shift (ΔE Value) of black colour was recorded from 7.73 to 8.34, while after gloss lamination the variation was observed from 8.83 to 9.53 on coated paper media printed using offset printing as depicted in fig. 7 (d).

Results and Discussion

The collected data was analyzed in order to describe the results in the form of information. The results of effects of Colour Shift due to various Lamination Techniques on Coated Media using Offset Printing process are tabulated in Table 1.

Colour Shift (ΔE Value)		**Lamination Techniques**							
		Gloss		**High Gloss**		**Matt**		**Silk**	
		Pre-Op	**Post Op**	**Pre-Op**	**Post Op**	**Pre-Op**	**Post Op**	**Pre-Op**	**Post Op**
Cyan	*Min.*	3.99	1.5	3.01	2.90	3.9	7.78	4.59	5.34
	Max.	3.99	3.47	3.01	3.57	4.44	8.15	5.15	5.81
Magenta	*Min.*	2.3	2.31	2.36	1.89	2.22	6.74	2.04	3.6
	Max.	2.3	3.02	2.36	2.17	2.32	7.23	2.55	3.92
Yellow	*Min.*	1.2	0.37	0.52	1.15	1.2	6.13	0.44	1.86
	Max.	1.2	3.47	0.52	2.02	2.2	7.62	2.27	3.61
Black	*Min.*	8	7.15	7.26	6.92	7.69	12.89	7.73	8.83
	Max.	8	7.77	7.26	8.12	8.18	13.67	8.34	9.53

Table 1: Colour Shift (ΔE Value) due to various Lamination Techniques

Conclusion

The research indicates an insightful effect of various lamination techniques (Gloss Lamination, High Gloss Lamination, Matt Lamination and Silk Lamination) on colour shift (ΔE Value) on coated paper media using offset printing.

i. **Gloss Lamination:** During research it was found that ΔE value for all process colour except black colour were in the acceptable range i.e. below 5 not only for pre-operation but also gloss lamination. It was found that the pre-operational (without lamination) colour shift i.e. ΔE value of cyan and black colour were more, while on the other hand post operation (gloss lamination) colour shift (ΔE) Value for both colour (cyan and black) was reduced on coated paper printed with offset printing. Pre-operation operational (without lamination) ΔE value of black colour was more, but post gloss lamination helped in reducing colour shift up to a certain extent. For magenta and yellow colour, ΔE

value were slightly increased after gloss coating on coated paper media, but within the standard and acceptable range.

ii. **High Gloss Lamination:** Colour shift (ΔE value) was inacceptable range before and after high gloss lamination on coated paper media for Cyan, Magenta and Yellow colour. Also post high gloss lamination effect where reduction of colour shift for magenta colour. For cyan and yellow colour, there was least colour shift (ΔE) prior to high gloss lamination which was increased but within acceptable range. The colour shift value (ΔE) of Black colour was more as compared to other process colour (Cyan, Magenta and Yellow), but post high gloss lamination helped in reduction of colour shift slightly.

iii. **Matt Lamination:** It was observed that the value of colour shift (ΔE) of process colour i.e. cyan, magenta, yellow and black colour were almost consistent prior to matt lamination, amongst which ΔE value of cyan, magenta and yellow was within acceptable range. But post matt lamination, colour shift (ΔE) value for all process colour were increased causing more colour shift on coated paper.

iv. **Silk Lamination:** It was found that prior silk lamination on coated paper printed using offset printing, ΔE value for all process colour except black colour were in the acceptable range. Post silk lamination on printed media nominal colour shift occurred for magenta and yellow colour. Also for cyan and black colour the colour shift was increased beyond acceptable range.

It is concluded that the colour shift (ΔE) value was reduced for cyan and black colour post gloss lamination on coated media, while for high gloss lamination colour shift value of magenta and black colour were reduced. There were more colour shift for all the process colour i.e. cyan, magenta, yellow and black post matt and silk lamination on coated paper media printed using offset printing.

References

Cinko, U. O., & Becerir, B. (2019). Dependence of colour difference formulae on regular changes of colour coordinates in CIELAB colour space. *Industria Textila*, *70*(3), 248–254. https://doi.org/10.35530/IT.070.03.1525

Elliot, M. W., & Cockburn, J. C. (2010). Print engine color management using customer image content. *2010 Western New York Image Processing Workshop, WNYIPW 2010 - Proceedings*, 38–41. https://doi.org/10.1109/wnyipw.2010.5649758

Jangra, V., Pandey, A., & Anayath, R. (2023). Hue difference on Super Print substrate: Study of various Digital Printing Methodologies. *Eur. Chem. Bull*, *2023*(4), 8662–8668.

Kipphan, H. (2001). Printing Technologies without a Printing Plate (NIP Technologies). In *Handbook of Print Media* (Vol. 60). Springer-Verlag,New York. https://doi.org/10.1007/978-3-540-29900-4_5

Majnarić, I., Mirković, I. B., & Golubović, K. (2012). Influence of UV curing varnish coating on surface properties of paper. *Tehnicki Vjesnik*, *19*(1), 51–56.

NIIR Board of Consultants & Engineers. (2017). Handbook On Printing Technology (offset, Flexo, Gravure, Screen, Digital, 3d Printing) 3rd Revised Edition by Niir Board Of Consultants & Engineers, ISBN: 9788178331768 | NPCS. In *Asia Pacific Business Press*

Inc.

Nunoo, F. K. N., Antwi, E. A., Moro, I., Appiah, I. K., & Churcher, E. W. (2019). Colour Consistency in Print: Ghanaian Printers' Knowledge and Awareness of Colour Management. *International Journal of Innovative Research and Development*, *8*(12), 56–63. https://doi.org/10.24940/ijird/2019/v8/i12/dec19039

Sotiropoulou, S., & Chryssoulakis, Y. (2000). An optimisation study of colour measurements on digitised slides of painted works of art. *Journal of the Society of Dyers and Colourists*, *116*(1), 23–31. https://doi.org/10.1111/j.1478-4408.2000.tb00005.x

Stiene, T., Urban, P., & Rodriguez-Giles, J. M. (2019). Prediction of lamination-induced colour shifts for UV offset printings by using a heuristic approach as well as machine learning techniques. *Journal of Print and Media Technology Research*, *8*(4), 199–207. https://doi.org/10.14622/JPMTR-1912

Yedid-am, R. I. L., & Il, T. I. L. (2011). *Accurate Printing of a Target Colour*.