

Digital printing as an alternative printing system for short run label production

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Abstract:

Flexography, Litho-offset, Screen and digital are the four basic printing systems used to apply graphics to paper and plastic based label, according to the field study of Egyptian market. The purpose of this paper is to identify the quality and cost drivers of selection of a particular process to print labels, as short run production. Flexography, litho-offset and screen are the three printing systems traditionally used to print labels. Digital printing system have been recently introduced to the industry in domestic market.

To achieve the objective of this paper, it was carried out through three main items. First item was achieved by comparing of technical specifications to select the suitable traditional system, where flexographic printing system was the most suitable system, which compared it with digital printing system according to estimated cost of producing a printed label to produce short run volume as second item. It was found that the cost of label printing was suitable by using flexography printing system for more than 30,000 units. On the hand, it could be considered that digital printing is very cost effective in high volume up to 30,000 units. Additionally, digital printing offers other benefits such as customized printing and variable data printing.

Last item of this paper was illustrated world latest trends of label production.

As main result of this paper. Digital printing system was offering an economical solution and add value in the domestic labels market to produce low volume of products, as well as used traditional systems to achieve medium and long run of production.

Keywords

- *Paper based label,*
- *Plastic based label,*
- *Litho-offset printing,*
- *Flexographic printing,*
- *Screen Printing,*
- *Ink Jet printing,*
- *Digital printing.*

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1. Introduction

Nowadays, label production are affected by digital printing system, specially with world trends to short run of production, also luxury products and minimize of cost⁽¹⁾.

The purpose of this research is to identify the primary drivers of selection of a particular process to manufacture and print labels. This research also explores the estimated cost of producing a printed labels using the traditional processes, with special emphasis on the relative cost of low volume printing.

Two factors have contributed to a shift in the cost of printed labels. There is an increase in the number of colorful displays, and have a much smaller run size⁽²⁾.

A number of factors influence the cost of color printing methods including prepress time, set-up/changeover costs, press production, and post-press operations⁽³⁾. Customers are moving to just-in-time and zero inventory and as a result the industry is moving away from traditional long runs to shorter runs. Shorter product life cycles and fragmentation of product markets have reduced the average print run to below 30,000 pieces of labels with few repeat orders. In some cases, the total annual set up time is longer than the annual net

production time.

The introduction of digital printing adds an attractive option for short runs. New generation digital printers can produce print quality. Without the need for prepress steps like producing films and/or plates, the total upfront cost has been reduced. As no plates are used in the process, set-up/changeover time and the start-up time can be reduced to minutes⁽⁴⁾.

2. Methods of Printing on labels

According to our domestic market, there are four basic printing technologies used to print on labels. The following four methods will be discussed:

- Flexography
- Litho-offset
- Screen Printing
- Digital Printing

2.1 Flexography printing

Flexography printing is the most common process in which the combined label is printed directly. It is typically used in the flexography which is a narrow web machine. The machine has the capability of one-pass multi-color flexographic printing, die-cutting and rewinding the manufacturer's joint. Label web blanks that are loaded on the feeding side of the machine. A printed, die-cutting, slitting and rewinding comes

out on the delivery side of the machine.

Flexographic printing resolution for flexography is about 48 lines/cm (120 lpi) using conventional production methods, as compared to 60-120 lines/cm (150 up to 300 lpi) for the Litho process⁽⁵⁾.

Flexographic printing process has a resilient relief printing plate made of photopolymer which enables printing on label surfaces. The printing plate act as rubber stamp and accepts ink from an anilox roller and transfers it to the substrate by the pressure of the impression cylinder⁽⁶⁾.

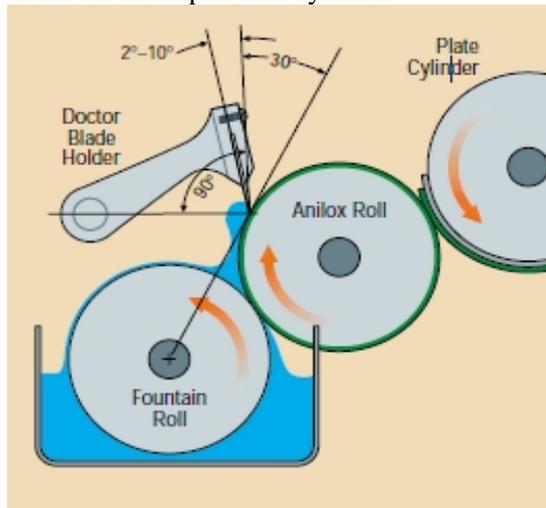


Figure 1: Flexographic Printing Process⁽⁵⁾.

More of both paper and plastic based labels are used flexographic printing system, by using UV printing inks, which drying immediately, and die-cutting process are inline on the same machine⁽⁷⁾.

One of most widely used machines in the local market is Gallus[®], which can be considered as one of specific machines to produce labels machines, following items are explained state of the art of label production in local market, which are as follows: -

- There are a relationship between resolution of graphic design and cell per inch (cpi) of anilox roller, most of presses in domestic market have anilox roller up to 600 cpi. To 1000 cpi. As a reason of it, it should be achieved graphic designs by screen ruling, where don't increase on 120 - 200 lpi (8).
- Hardness of printing plate play an important role to ink coverage force on substrate.
- Thickness and hardness degree of double adhesive tape can be influenced on the printing quality.
- Ink film thickness is ranging between 0.75 to 2 microns (9).
- Most of printing machines manufacturers recommended to clean anilox roller by specific process, but during field study in domestic market can notice that more of printing houses

don't proper clean it, leading to many printing problems .

- High cost for flexographic printing plate making compared to other impact printing systems.
- Cost of waste can be calculated as fixed quantity of make-ready to obtain OK printed sheet.

As a result, there are a relationship between order quantity and cost of per unit, where increased of run job-order, lead to decrease of product cost.

Also the main advantage, it can be produced both type of label (paper- and plastic-based).

2.2 Litho-offset printing

Litho-offset printing system is used to produce label in limited applications. Till now don't used specific printing presses, i.e. narrow web-fed litho-offset with UV drying, which designed to print label.

Egyptian Printing houses depended on using commercial sheet-fed litho-offset presses by used cold-set inks. After printing finished, printed sheets are treated by offline UV varnish coating unit, to create thin uniform thickness layer of varnish to enhance and protect products against rubbing, scratch and scuff .

Some of local printing houses are used two units, and others used four units of sheet fed printing machines, size ranging between 50x70cm and 35x50cm⁽⁷⁾.

Offset printing offers a very high quality print and among all the process, litho-offset has the best print quality. Lithography has 150 lpi or better screen resolution. The substrate used for printing almost always has a paper based label and comes in different varieties⁽⁶⁾.

Litho-offset is used for fairly long runs but much shorter than flexo print. The minimum quantity to make the process economical is around 20,000 prints and there is no maximum number of prints. It can go up to over 100,000 print or more. However, the process would not be as economical as flexo print process for such a large quantity.

According to field study, there are main items, which should be considered when used litho-offset printing system, can be listed in the following points,

- used only with the paper based labels,
- possibility to produce multi colors graphic designs up to 175 line / inch,
- interest of imposition and relationship with grain direction of paper,
- possibility of printing by used food inks, to can achieved it with many sector such as food, medicines ... etc, and
- Die-cutting and UV varnish processes are

available as separated units.

According to previous items, it can conclude that when used litho-offset there are two difficult points. Firstly, Increase of waste percentage, due to the product pass in three separated phases processes (printing, UV varnishing and Die-cutting), secondly, it can produced plastic based label.

2.3 Screen Printing

Screen printing can be considered as an oldest printing system ⁽⁶⁾, which used to print on paper and plastic based labels, but till now in local market, it used the manual printing process.

More Conventional dimensions of stencil up to 35x50 cm, by used paper screen inks to print on paper based label and Plastic inks to print on plastic based label.

According to filed study ⁽⁷⁾ in Egyptian market, the main items, which should be considered when used screen printing system,

- screen printing can be considered as an oldest printing system, which used to print on paper and plastic based labels, but till now used manual printing process.
- More Conventional dimensions of stencil up to 35x50 cm, by used paper screen inks to print on paper based label and plastic inks to print on plastic based label.
- There are a relationship between screen ruling of film and screen ruling of stencil. It should be that screen ruling of film is equal $\frac{1}{4}$ screen ruling of stencil⁽⁶⁾.
- It is difficult to print by used high screen ruling of stencil, due to accelerating drying time of inks and clogging the mesh of stencil, which leads to printing problems and increase of the waste.
- It can be considered that cost of stencil preparing was low somewhat of other printing systems .
- Still methods of preparing stencil in domestic market based on direct manual method, and were therefore dependent on labor skillful, and often decrease or increase the thickness of the material sensitive negatively affect print product quality.
- Increase ink's film thickness on final product, as it is up to the thickness of about 20 microns, leading to poor rubbing resistance.
- It can be considered that screen ink consumption is high rate compared to other impact printing systems ⁽⁶⁾.
- Screen printing production are considered low speed, if they are comparable to other impact printing systems.
- Run length is about 4000 print/ stencil.

Consequently, applications that are performed by using screen printing system was limited in terms of applications, which can be concluded in the following items,

- label Applications that didn't need be taken up by hand several times (such as labels, which stacked on automotive, glass doors, and windows, which used in restaurants, hotels, and offices).
- Excluding graphic designs that contain color halftone images, for the following reasons:
 - o More of Egyptian presses used 120 line / inch as screen ruling of stencil, which leads to the production of screen ruling images of not more than 30 line / inch, as a reasons, it can be used only to produce line and solid graphic design and not suitable for halftone design.
 - o Increased of thickness ink film works as the negative impact for quality halftone printing, also to produce small points of letters.

Screen printing system were suitable for short and medium-run production, and were not used in a long-run production due to the speed of depreciation of stencil.

2.4 Digital Printing

Nowadays, Ink Jet printing system (Drop on Demand) ⁽⁷⁾ is used only in our market to produce short run label. However, these machines are not specially to produce label as world classification for following reasons;

- All Digital printers, which used in this filed can be considered as traditional multi-colored print A4 or A3 sizes, and in few cases to print on 35 x 50 cm., by used water based inks. According to this reason, inks are weak resistance to friction and therefore must be used Varnish process in separate machines to apply thin layer of UV varnish to protect printed image against friction and rubbing.
- Also die-cutting process are carried out by separated machines.

3. A comparison between impact and non-impact printing systems in label printing

According to our studies, it can be analyzed printing systems in local market to clarify their suitability for label production in short run quantities, as shown in Table (1).

Table (1): Comparative study between printing systems to produce label in domestic market.

No.	Printing Systems Comparable Items	Flexographic printing system	Litho-offset printing system	Screen Printing System	Digital Printing Systems
					Water Based Inks
1	Label substrates	Paper/Plastic based	Paper Based	Paper/Plastic based	Paper Based
2	Screen ruling or Resolution	120 lpi	175 lpi and more	40 lpi	360 dpi×360 Or 720 dpi×360
3	Possibility of halftone image production	Very good	Excellent	Weak	Very good
4	Printing machine	Narrow Web	Sheet -Feed	Sheet –Feed	Sheet –Feed
5	Ink film thickness	0.75-2 μm	2 μm	~ 20 μm	6 Pico miter
6	Adhesion force	good	Medium	Medium	Weak
7	Printing speed	High	High	Low	Low
8	Production speed	High	Medium	Low	Low
9	Ink type	UV Inks	Cold set inks	Cold set inks	Water Based Inks
10	UV varnish unit	In-line	Off-line	Off-line	Off-line
11	Die-cutting Unit	In-line	Off-line	Off-line	Off-line
12	Waste ratio (Make – ready)	50 m / color	100 sheets/ printing process	10 sheets/color	No
13	Waste ratio (finishing processes)	No Waste	20 sheets / UV & Die-Cutting	20 sheets / UV & Die-Cutting	20 sheets / UV & Die-Cutting

As a result of table (1), it can be mentioned that more suitable printing process to achieve the aim of this paper is flexography and digital printing systems, which can be achieved to produce both types of labels, also they are more practically used in our domestic market.

digital printing system in label printing.

To compare cost for several run lengths of job orders as same technical specifications (4 colors, halftone graphic design, and size 5 x 10 cm, plastic label based), as mentioned in table (2).

4. A comparison between flexography and

Table (2): Cost study of variable labels job orders by using both flexographic and digital printing systems

Job order (Number of labels / Job order)	Flexographic Printing System		Digital Printing System	
	Total Cost (Egyptian Pound)	One piece of product (Egyptian Piaster)	Total Cost (Egyptian Pound)	One piece of product (Egyptian Piaster)
1000	1238	123.8	318.6	31.86
2000	1256	62.8	368	18.4
3000	1274	42.5	418	13.93
4000	1292	32.3	467	12
5000	1310	26.2	517	10.33
6000	1328	22.1	566	9.4
7000	1346	19.2	615	8.8
8000	1364	17	665	8.3
9000	1382	15.4	714	7.9
10000	1400	14	764	7.6
15000	1490	9.9	813	7.4
16000	1508	9.4	863	7.2
17000	1526	9	913	7.2
18000	1544	8.6	962	6.9
19000	1562	8.2	1011	6.7
20000	1580	7.9	1234	6.7
40000	1940	4.85	2517	6.3
80000	2660	3.3	5035	6.3
160000	4100	2.7	9739	6
320000	7080	2.2	19478	6
640000	13340	2.1	38687	6
1280000	25760	1.9	77373	6
2560000	51650	1.9	154477	6
5120000	100370	1.9	308954	6

When comparing between flexography and digital printing, as shown in Figure (3), it can be found that cost of about 30,000 of pieces can be carried out by digital printing, On the other hand,

when number of products are increased more than 30,000, it can be considered that flexographic printing is more economical than digital.

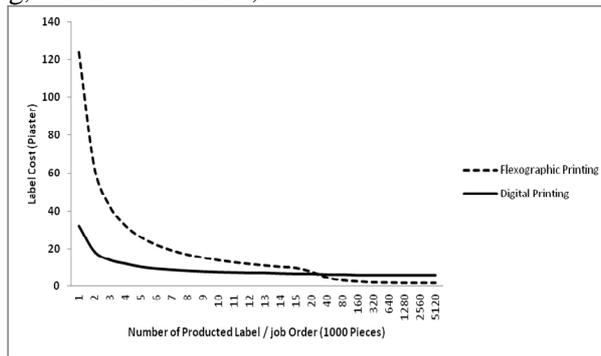


Figure (2): Cost comparative between digital and Flexographic printing systems.

5. World latest trends for label production

It is known that print labels sector has more of progress as a result of digital printing development, which realize the consumer need for excellence in the form and graphic designs as well as the global trend now is to obtain short run (i.e., small number of products).

As a result, it has been much of developments that have affected on this sector, which led in fact to the flexibility and reduce production costs and thus to an increase in sales volume, where label market consists sticking to quantitative market and luxury market which is based on short run of production⁽¹⁰⁾.

Recently, Label production can be classified to two main trends;

- Impact printing, and
- digital printing.

It should be mentioned the differences in production workflow for both systems, as shown in Figure 3, which shows the eliminate many productive stages in the workflow of digital production such as proof production, and plate making processes, make-ready of press , and waste of production start.

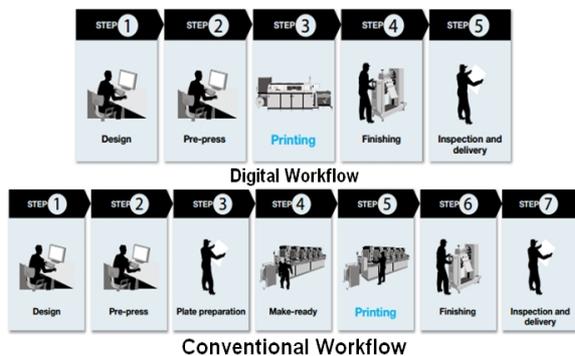


Figure (3): Comparison between Digital and Conventional Workflow⁽¹³⁾.

5.1. Conventional Printing systems

In the state of label production, Gallus® can be considered as famous trade name of label presses manufacturer, which supports six printing

processes and is redefining the future of label printing. The platform concept, modular design and high level of automation enable label printers to produce top-quality short and medium-sized runs cost-effectively.

5.2. Modular inline press with direct drive technology; that can be configured and retrofitted at will. The printing processes can be interchanged without separating the web. Major reduction in job changeover times coupled with minimal waste thanks to high levels of automation in all modules. Dynamic feed, web tension presetting, length and cross register presetting, automatic washing units, etc. Access to machine setting data from the main memory for repeat jobs. Remote diagnosis via Internet. Extremely economical use of all resources for maximum eco-efficiency.

The main features of the latest conventional trends in this field are: UV offset, UV flexographic and rotary screen printing, solvent rotogravure, hot foil embossing and cold foil printing – separately or in combination; finishing options including coating (varnishing) and lamination⁽¹¹⁾.

5.2. Digital Printing Systems

There are more of manufactures, which introduce complete solutions to label production, when we studied the main properties of these machines, it can be reached to the following important points:

- 1- All of them worked by drop-on-demand Ink Jet mechanism.
- 2- Do not need plate making.
- 3- Cleaning print heads automatically.
- 4- Do not need clean process between changeover.
- 5- Do not need any registration for plate or substrates.
- 6- Cost Minimizing to lower level, which compared with other impact printing systems.
- 7- All presses have laser die-cutting units.
- 8- All presses have web fed system.
- 9- All presses compatible with color management programs.



- 10- Feasibility to carry out finishing process.
- 11- Cost depends on ink price.
- 12- Possibility to produce more Variety of orders and short run production, and can be proofed

on the same machine.
Table (3) shows the comparison between some of digital label productions machines.

Table (3): Comparison between Digital Printing Machines used in labels Production

Items	EFI – Jetrion 4900 Machines ⁽¹²⁾	EPSON - Sure Press L-4033A and L-4033AW Machines ⁽¹³⁾	Dotrix Modular Machines ⁽¹⁴⁾	LinoPrint L Series (Heidelberg) Machines ⁽¹⁵⁾	CDT3600 Machines ⁽¹⁶⁾	Dilli NEOMERCURY Machines ⁽¹⁷⁾
Ink Type	UV Inks	Water based Inks	UV Inks	UV Inks	UV Inks	UV Inks
Number of Colors	4 colors + White	6 colors	4 colors	4 colors	4 colors + solid colors	4 colors
Material Width	229 mm	330 mm	650 mm	430 mm	238 mm	230 mm
Actual width for Printing	210 mm	315.5 mm	630 mm	420 mm	219 mm	216 mm
Speed	14.24 meter/minute	5 meter/minute	24 meter/minute	48 meter/minute	69 meter/minute	5 meter/minute
Resolution	1080 dpi	720×720 dpi	900 dpi	600×600 dpi	1375×1600 dpi	1200×1200 dpi

6. Results:

- a. In our domestic market;
 - i. There are not any label specified presses, which were known in the world market for litho-offset, Screen, or Digital printing systems.
 - ii. It could be considered that digital printing was lower cost than other conventional printing systems, specially for short run productions.
 - iii. The proportion of waste rates in conventional systems were higher than digital systems, consequently increasing cost specially for short-run production using traditional systems.
 - iv. Digital label printers depended on drop-on-demand ink jet mechanism.
- b. In world market;
 - i. Digital printing manufacturers introduce a complete solution to produce finished label as an in-line production system.
 - ii. impact printing system can be considered as hybrid systems, i.e. modular machine may be consists of flexographic, letterpress, screen, rotogravure, hot and cold foil stamps units.

7. Recommendations:

Although advantages and characteristics of digital printing in label production, they did not come to eliminate impact printing systems, but to provide an integration and economic solutions to short run label production.
In domestic market, it should be required specified label printers to get minimize costs (i.e. costs of varnishing and die-cutting phases) and suitable quality to future Market demand.

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