Designing a Scientific Methodology to Use the Principles of Graphic Design to Control the Costs of Printing Products

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Abstract:

This paper presents a scientific methodology for controlling printing product costs through graphic design principles. The study aims to establish the relationship between graphic design and printing technologies across different production processes and propose a strategy for using graphic design principles to control the cost of printed products. It identifies two types of costs associated with printed products: Direct costs (related to production processes and materials) and indirect costs (including fixed costs, administrative processes, external production operations, and variable expenses).

The paper proposes a clear and specific scientific methodology for graphic design in printed products, integrating graphic design with all subsequent production processes to ensure full control over quality and cost. The strategies to reduce costs through graphic design processes include controlling the number of colors used, using minimalism principles, using digital file creation techniques, implementing ink control techniques, using advanced color management systems, simplifying finishing operations, and leveraging artificial intelligence applications for all design processes.

The results show that implementing these strategies can lead to significant cost savings, such as reducing ink quantity, reducing the drying time, and adjustment time for printing machines. The application of minimalism principles also produces designs that effectively communicate brand identity while saving money.

In assumption, the purpose of scientific methodology and strategies is to provide a comprehensive approach to controlling costs in printed product production by integrating graphic design principles throughout the printing operations. The endorsements emphasize the importance of adopting this methodology and implementing the suggested strategies to optimize cost control efforts in the printing industry.

Keywords:

Graphic design, Cost control, Printing industry, Printed products, Printing cost.

الملخص:

تطرح الورقة البحثية منهجية علمية لمراقبة تكاليف منتجات الطباعة من خلال اســتحدام التصــميم الجرافيكي للمطبوعات. وتهدف الدراسـة إلى إبراز أهمية تكامل العلاقة بين التصـميم الجرافيكي وتكنولوجيات الطباعة عبر مختلف عمليات الإنتاج واقتراح منهج علمي يتضـمن عدة اسـتراتيجيات لاسـتخدام مبادئ التصـميم الجرافيكي في خفض تكلفة المنتجات المطبوعة. حيث تنقسم تكاليف المنتجات المطبوعة: التكاليف المباشرة (المتصلة بعمليات ومواد الإنتاج) والتكاليف غير المباشرة مثل التكاليف الإدارية والخدمات والشحن والصيانة.)

وتقترح الورقة منهجية علمية واضحة ومحددة لتنفيذ التصميم الجرافيكي للمنتجات المطبوعة، حيث يتم ربط التصميم الجرافيكي مع جميع عمليات الإنتاج التي يتم تنفيذها بعد مرحلة التصميم وذلك لضمان السيطرة الكاملة على الجودة والتكلفة.
وتشمل الاستراتيجيات المستخدمة في خفض التكاليف الكلية للمطبوع من خلال عمليات التصميم الجرافيكي تخفيض عدد الألوان المستخدمة، واستخدام مبادئ التصميم البسيط، واستخدام تقنيات إنشاء الملفات الرقمية، واستخدام تقنيات يمكن من خلالها التحكم في كميات الحبر المستخدمة، واستخدام نظم متقدمة لإدارة الألوان، وتبسيط عمليات التشطيب النهائي للمنتج المطبوع، والاستفادة من تطبيقات الذكاء الاصطناعي.
واستناداً إلى النتائج، يُنصح المصممون باتباع منهج علمي منذ المراحل الأولى للتصميم الجرافيكي من أجل التحكم بنجاح في التكاليف وضمان رضا العملاء.
وعلاوة على ذلك، تشدد هذه الورقة على أهمية وضع تقنية واضحة ومحددة لتحديد تكلفة كل منتج من المنتجات المطبوعة وتبحث العلاقة بين التكاليف ومراحل الإنتاج اللاحقة من حيث الوقت والتكلفة والنوعية. ويمكن للتصميمات أن تحدد إجراءات الإنتاج التي لها تأثير مباشر وغير مباشر على التكلفة الإجمالية عن طريق النظر في المواصفات التقنية وعمليات الإنتاج ذات الصلة بكل منتج. وتمكن هذه المعرفة المصممين من إصدار أحكام مستنيرة أثناء عملية التصميم البصري من أجل التحكم بكفاءة في النفقات.
وأخيراً، يمكن لمنظمات قطاع الطباعة أن تعزز قدرتها التنافسية وربحيتها واستدامتها في سوق الطباعة التي يجري تعديلها باستمرار عن طريق تنفيذ هذه التوصيات.

الكلمات المفتاحية:
التصميم الجرافيكي، مراقبة التكلفة، صناعة الطباعة، المنتجات المطبوعة، تكلفة الطباعة

Introduction:

The world is facing many economic and environmental problems, which have made it necessary to seek practical solutions to these problems scientifically by reviewing many methods, procedures, and methods of work and production in all areas of industry, including the printing industry, which is a common factor in almost all world industries. With the growing global economic crisis and the printing industries association with many industries and products, particularly in product marketing and packaging, many methods and approaches to controlling the economics of printing products have had to be studied to reduce printing product costs while maintaining quality and production factors on time (Done, R., Warner, R. & Noorda, 2022).

On the other hand, due to the steady rise in raw material prices, employment costs, machinery and device expenses, and rapid technological advancements, it has become necessary to create a non-traditional systematic production system that helps control publication costs. These effects can be divided into three main factors that control the overall cost of a product, namely time, and are subject to two variables: The delivery of production processes at the lowest time and the delivery of the product at the appropriate time. Quality is subject to two fundamental variables: Product quality to meet client needs and the quality of production processes to be performed for product production. Finally, the cost is subject to one variable printed product with the required specifications and quality at the lowest possible cost, which can be represented in Figure 1 (Moreira, A., et al., 2018). Therefore, the research is
focused on the factors that affect the cost of printed products.

The extent, to which it affects other factors in terms of increases or decreases, as well as the change in the cost of printing products using the basics and techniques of graphic design, will be indicated.

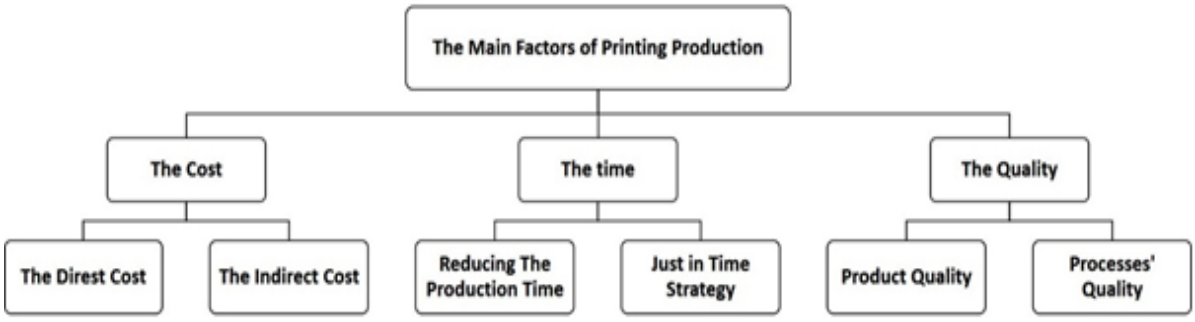

figure 1: the main factors for the printing production

The Research Problem

The absence of a scientific methodology for controlling the costs of printed products by using graphic design fundamentals and techniques poses a significant problem.

The Research aims

The research aims to achieve the following:

1. Explain the relationship between graphic design and printing technologies in all different production processes.

2. Suggest a strategy for using graphic design fundamentals and techniques to control the cost of printed products.

The Research Methodology

Using the descriptive analytical approach to develop a scientific methodology for controlling the costs of printing products by utilizing graphic design principles.

To achieve the research aims, the following is studied:

١- Printed Product Costs

The costs of the printed product are divided into two types: Direct costs and indirect costs. The direct costs are concentrated in production processes and materials. On the other side, the main categories of indirect costs include fixed costs, administrative processes, and external production operations involving external suppliers; variable expenses from extra time and temporary employment; and relocation. The total cost of the printed product is therefore equal to the total direct cost plus the indirect cost.

2- Factors Influencing the Printed Product's Price:

The cost of the printed product depends on various basic factors, such as:

1. Paper types and weights.
2. The quantity and quality of materials used, such as glues, textiles, cardboard, staples, etc...
3. The quantity of requested printed products.
4. The printing system to be used.
5. Numbers and types of production processes are used.

It is critical to have a clear methodology for costing each printed product and analyzing the relationship between the costs of each phase and the following stages in terms of time, cost, and quality. This is due to the variety of technical specifications and the mix of production processes, which vary from product to product. Several of the production techniques that will be used in the upcoming stages of production can be identified and have a direct and indirect

impact on the overall cost of the printed product, as all printing products start with the graphic design process, which is the first step that comes before all other production processes; we will go into detail about this impact.

3- The Proposed Scientific Methodology for Graphic Design in Printed Products:

Dealing with printed products is very similar to what already happens with product design methodology, which, according to (Wen-Qiang Li) includes a complete product study in terms of technical specifications, manufacturing processes, and total costs until reaching the final product stage that meets the client's needs. As a result, the graphic design of the printed product must be based on a clear scientific approach from the beginning to all subsequent stages of production, so that the level of quality required and the total cost are fully controlled. The graphic design process integrates with all subsequent production processes and determines all of the costs required to implement the product, the time required to produce it, and the level of quality required by the customer. Accordingly, several factors need to be taken into consideration before the process of graphic design begins, such as the specific costs of producing graphic design in all production processes as a whole, and the technologies used to produce the graphic design. Therefore, we should have a clear and specific methodology with sequential and overlapping stages used to produce a graphic design of the printed product, with a focus on the aspect of controlling costs.

4- The Scientific Methodology Proposed for Cost Reduction Using Graphic Design Processes:

The processes of graphic design for any kind of printed product are carried out by applying the rules and basics of graphic design, but this could be done using specific strategies and concepts. The application of these strategies and concepts may vary from product to product. Therefore, the researcher suggests various strategies during the various stages of implementing graphic design (shown in Fig. 2), and these strategies include:

4-1 The Total Number of Colors.
4-2 Use of Minimalism School in the Design.
4-3 Techniques for Creating Digital Files.
4-4 Ink Control Techniques.
4-5 Using Advanced Color Management Systems.
4-6 Simplifying the Final Finishing Operations of the Printed Product.
4-7 Using Different Types of AI Applications.

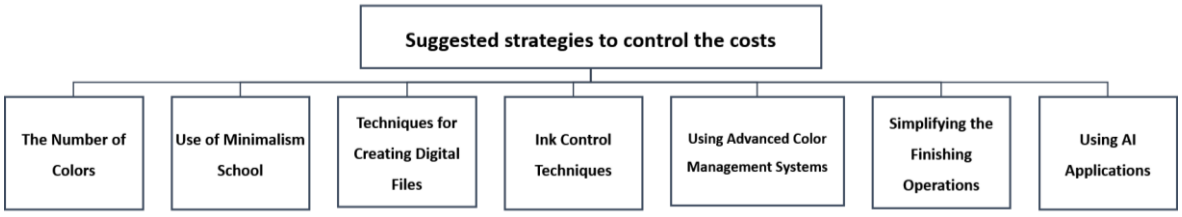

FIGURE 2: SUGGESTED STRATEGIES TO CONTROL THE COSTS

4-1 The Total Number of Colors:

The graphic designer can control the economic costs of publications when designing them by following a strategy for the number of colors that will be used in the literature. The printed publications may be produced in one color or sometimes up to six colors (four basic CMYK

and two special colors). Special colors may be used as brand colors and printed separately for a variety of reasons, such as preserving color values from changing during all printing production stages or using special colors that are unavailable in the CMYK range.

For example, when the designer reduces the colors to monochrome or two colors, the cost will be reduced because that will lead to a reduction in the number of plates, the number of colors, the time required for the drying of the printed material, total production time, indirect costs of machines and power consumption, and working hours. As shown in Fig 3, this is an example from a press house printing 1000 copies of an A5 flyer and it is clear the difference in cost depends on the number of colors.

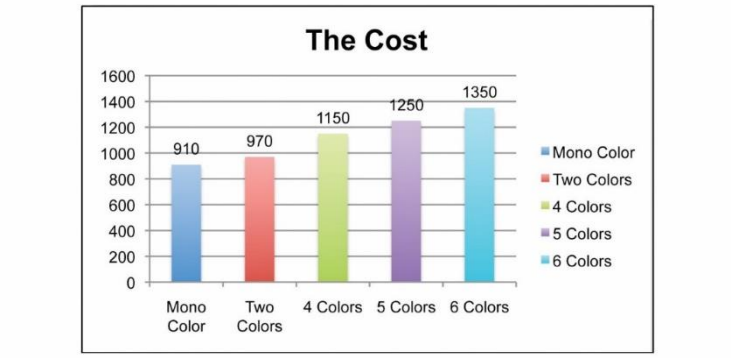

FIGURE 3: THE RELATION BETWEEN THE NUMBERS OF THE COLORS AND THE FINAL COST FOR THE SAME PRODUCT

4-2 Use of Minimalism School in the Design:

Minimalism is the extreme outcome of the 20th-century Modernist movement and the main concept of this movement is "less is more." Modernists were reacting against the exuberance and realism of the 19th-century art, creating buildings, furniture, and graphic design that celebrated the fundamentals of shape, form, and color. (shutterstock.com)

Minimalist design aims to convey ideas clearly and effectively by using only the most basic components. It can help communicate the brand's identity, draw attention, and save money. There are some main principles to creating a minimalist in any printed design (Shown in Fig 4), such as using a small color scheme that complements the product's attributes and company personality and restricting the use of colors and gradients. In addition, using White space can emphasize key information and create contrast and simple geometric shapes or icons to convey product qualities, such as a star for high quality or a circle for eco-friendliness. Use readable, clear Sans- serif fonts that complement the product's style and are easy to read, avoiding intricate or decorative fonts. Moreover, avoid using excessive labels or text, providing only necessary product details like name, ingredients, directions, and safety precautions. Finally, avoid unnecessary words or phrases that can clutter the design and confuse customers. (99designs.com)

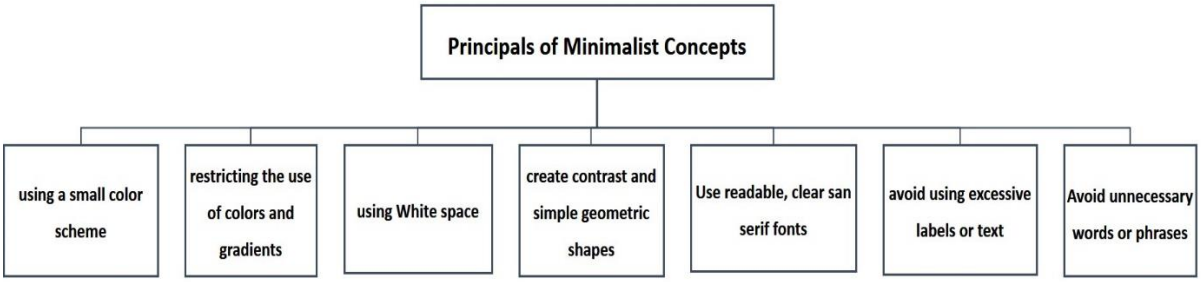

FIGURE 4: PRINCIPALS OF MINIMALIST CONCEPTS

The implementation of these concepts leads to reduced quantities of ink because the design contains large white spaces, which decreases the drying time of printed sheets and the adjustment time for the printing machine, reduces energy, and ultimately reduces the total cost of production (Shown in Fig. 5).

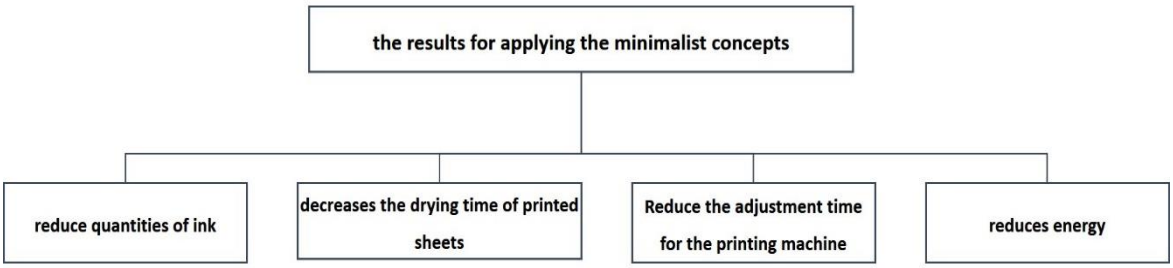

FIGURE 5: THE RESULTS OF APPLYING THE MINIMALIST CONCEPTS

4-3 Techniques for Creating Digital Files:

The designer will use various techniques when creating the digital files (Löwgren, 2002). Therefore, he will use image-editing applications to produce the final artwork for the products, and these techniques are:

4-3-1 Create the file with the exact appropriate resolution that is suitable for the screen rolling. Therefore, the designer can use this equation:

(Image resolution = screen rolling x quality factor (1.5:2) in order to create digital designs and photos. Increasing the resolution will increase the production time and decreasing the resolution will lead to loss the quality. (Adam Wright Design.com)

4-3-2 Use the lowest possible number of layers in the images because each layer is treated as a separate file by the computer's memory. Therefore, the reduction of the layers allowed as many production processes such as photo editing, color separation, and color proof as possible to be completed in the shortest possible time. (Adobe.com)

4-4 Ink Control Techniques:

These techniques are essentially linked to the printing phase and show the direct relationship between the use of certain techniques at the graphic design and printing stages.

These techniques are:

4-4-1 Avoid using solid colors for the design's background:

This leads to the consumption of a large amount of ink to fully cover the paper surface. Sometimes it may take two normal cycles of printing. In addition, more time is consumed in

the printing process by slowing down the speed of the printing machine to allow sufficient time for drying ink or using dry powder to increase the drying rate within the printing machine before reaching the feeding table. It may reduce the incidence of some typographical problems such as lubrication and the phenomenon of dot growth.

4-4-2 Using for Gray Component Replacement (GCR)

This technique is used to remove the colors of cyan, magenta, and yellow from the grey areas and replace the black with the degrees of the different color grades. This technique is directly aimed at reducing the cost of using ink since the cost of black used in printing the four basic colors is 20% to 50% lower depending on the type of printed product in which we use this technique, as shown in Fig. 6.

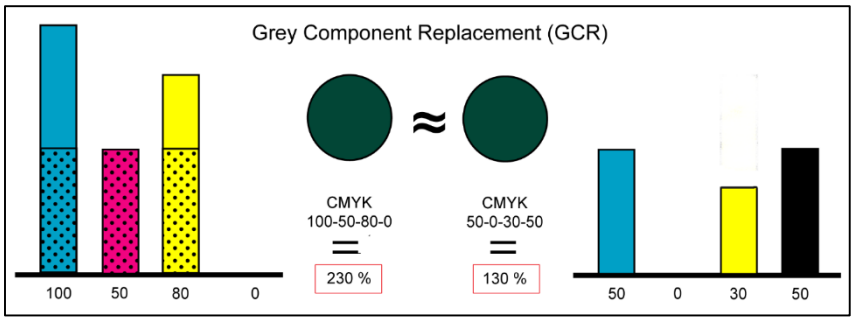

Figure 6: Using GCR to reduce the cost of printing

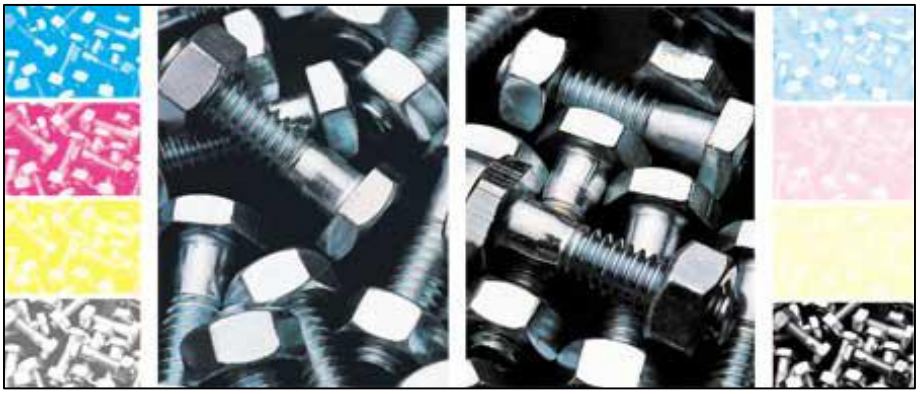

Figure 7: Applying the GCR technique to the image

This technique is applied during the design process. For example, if we assume that there is a dark green color of Y80 - M50 - C100, the formula for the ink film is C50 - Y30 - M0, and, in a simple calculation, the sum of the ink film is 230%. After the application of the technique, the sum of the ink film is 130%. That is, the savings rate on the total ink film was 100%. The designer can seize and control **GCR** from the Color Settings list in Adobe Photoshop or RIP software, and the application of GCR is very clear in Fig 7.

Finally, the advantages of applying this technique are:

1. Reduce:

a. The amount of ink used in the three basic CMYs is reduced by replacing black in the grey grades, which lowers costs because black is the least expensive color.

b. The time preparation for the printing machine.

c. The incidence of the phenomenon of pivot growth increases the quality of the printed product.

2. More control for the printing process because there is no need to spend more time fixing the three colors to get a grey degree that does not tend to be cyan or magenta.
3. The control of high-shadow areas leads to print quality.

4-5 Using Advanced Color Management Systems:

Following (Fowler, S. & Pieroux, A... 2007) discussing the Integration of color management systems into graphic design, found that workflows should offer significant benefits for reducing the cost of printing products by:

1. Automating color analysis and adjustment tasks reduces the time spent on manual corrections, which enhances efficiency and saves time.
2. Maintaining consistent color reproduction across different devices, substrates, and printing processes is essential for brand identity and customer satisfaction.
3. Ensuring accurate color mapping and calibration, minimizing color variations and discrepancies.
4. Reproducing colors consistently, these systems eliminate the need for costly reprints and reduce waste, material costs, and customer dissatisfaction.
5. Automating the color correction process reduces reliance on manual interventions because they help mitigate this issue by ensuring accurate color output from the start.
6. Enabling the creation of accurate color proofs that closely resemble the final printed output, which is cost-effective.

4-6 Simplifying the Final Finishing Operations of the Printed Product:

The finishing operations methodology falls under the comprehensive view of the product design process, and its limits may directly and explicitly exceed those of the graphic designer. However, communication between the graphic designer and the finishing departments is required to agree on several technical considerations that must be taken into before carrying out the graphic design process, such as the degree of difficulty or ease of the finishing processes that will be performed on the printed product. Furthermore, the finishing processes and technical specifications vary from one product to another, and the degree of difficulty varies (Guidelines for using print production standards - iso.org). Therefore, the designer should choose the simplest and easiest implementation methods that require the least amount of time and materials.

4-7 Using Various Types of Artificial Intelligence Applications:

Artificial Intelligence has been used in graphic design to automate tasks and reduce the time and cost of production. Here are some suggested AI applications that can be used to reduce the cost of printed products in graphic design:

1. Automated color correction: Fotor's AI-powered photo editor online (fotor.com) application can be used to automate the color correction process, reducing reliance on manual interventions, minimizing color variations and discrepancies, and editing multiple photos at once, significantly improving efficiency and workflow. In addition, the designer can use desktop AI applications, such as (Topaz Gigapixel AI, Corel PaintShop Pro, Aurora HDR, Bigjpg, Photo Pos Pro, and Photolemur).
2. Automated image editing: Jasper AI Art Generator (jasper.ai) can be used to automate image-editing tasks such as background removal, making the background transparent or easily replaceable.

3. Automated batch editing: Fotor's batch photo editor can be used to edit multiple photos at once, significantly improving efficiency and workflow.
4. Automated text-to-image conversion: Midjourney can be used to transform any text into realistic high-quality images.
5. Automated font pairing: Fontjoy (fontjoy.com) uses AI to suggest font pairings that complement each other, saving time and effort in the design process.
6. Automated image tagging: Google Photos (google.com/photos) uses AI to automatically tag images with relevant keywords, making it easier to search for images and improving workflow.
7. Automated image recognition: Adobe Sensei (adobe.com) uses AI to recognize objects in images and automatically apply appropriate tags, making it easier to search for images and improving workflow.
8. Automated color palette generation: Khroma (khroma.co) uses AI to generate color palettes based on an image, simplifying the color selection process.

Finally, it is important to understand that AI is not a replacement for human creativity and expertise. Rather, a tool can help designers work more efficiently and effectively. By using AI in conjunction with human creativity, designers can create high-quality designs while reducing the cost of production.

5- Conclusion:

In conclusion, developing a scientific methodology to control printing product costs using graphic design principles. It identifies the lack of such methodology and aims to explain the relationship between graphic design and printing technologies and production stages. Factors influencing costs include paper types, materials, quantity, printing systems, and production processes. The proposed approach integrates graphic design with production processes to control quality, time, and cost and finally reduce the cost of printed products. Strategies for cost reduction include using fewer colors, simplifying design, creating digital files, ink control techniques, advanced color management systems, simplifying finishing operations, and utilizing AI applications. The study emphasizes the importance of addressing economic and environmental challenges through scientific approaches.

6- The Results:

From the research study; the following results were reached for several strategies to reduce costs in the graphic design process for printed products, without compromising quality.
These strategies include:
1- Minimalism in design.
2- Reducing color usage.
3- Using digital file techniques.
4- Ink control methods.
5- Sophisticated color management systems to ensure precision and waste reduction.
6- Simplifying the Final Finishing Operations.
7- Incorporating AI applications for image editing, management, archiving, and design. The integration of AI apps improves cost control and optimizes design iterations, making businesses more competitive and sustainable.

8- Strong communication between the graphic design and production departments is crucial for the efficient use of this methodology.

7- Recommendations:

Based on the findings, the researcher recommends the following recommendations which can lead to substantial cost savings, improved efficiency, and maintenance of high-quality standards that enhance the competitiveness and contribute to the sustainability of the printing industry, such as:

1. Graphic design studios and press houses should adopt strategies such as limiting color usage, simplifying designs, utilizing digital file techniques, implementing ink control techniques, and leveraging advanced color management systems.
2. The integration of AI applications into the graphic design process should be considered to optimize cost reduction and efficiency.
3. Ongoing evaluation and refinement of these strategies are crucial to ensuring continuous improvement and alignment with emerging advancements in graphic design and printing technologies.
4. Organizations should prioritize sustainable economic practices by reducing material waste and optimizing resource utilization. Investing in the necessary infrastructure, training, and expertise to successfully integrate and utilize AI applications.

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