

ANALYSIS OF THE PRINTING INDUSTRY CONCERNING THE USE OF ECOLOGICAL PRODUCTS

ANA PATRÍCIA BRAVO DA SILVA

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Ana Patrícia Bravo da Silva
1161434

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School of Engineering, Polytechnic of Porto
Department of Mechanical Engineering

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Ana Patrícia Bravo da Silva
1161434

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School of Engineering, Polytechnic of Porto
Department of Mechanical Engineering



JURY

President

Doctor Luís Carlos Ramos Nunes Pinto Ferreira
Adjunct Professor, School of Engineering, Polytechnic of Porto

Guidance

Doctor Francisco José Gomes da Silva
Adjunct Professor, School of Engineering, Polytechnic of Porto

Co-orientador

Doctor Aldina Isabel de Azevedo Correia
Adjunct Professor, School of Technology and Management, Polytechnic of Porto

Arguing

Carina Maria Oliveira Pimentel
Auxiliar Professor, University of Aveiro

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KEYWORDS

Printing industry, printing, offset, Hypothesis test, Statistics, Environment, Sustainability, Environmental Impacts and Waste

ABSTRACT

One of the issues of great importance and under discussion in the printing industry is the recent demand for environmentally sustainable processes and products. Nowadays this theme can no longer be ignored. It is not just the preservation of the environment that is at stake. The future profitability of companies in the sector is directly linked to the way sustainable production issues are addressed today. The question is: what must we do to make printing an ecologically sustainable process?

The answer lies in changing habits: reducing waste and buying organic products, for example, both reduce environmental impact and increase the value of the product. In this aspect, the most important thing is to train employees properly. In addition, caring for raw materials also makes the difference: the use of recyclable coatings and laminates, as well as adhesives low in VOC (Volatile Organic Compounds), similarly reduce environmental impact and increase product value.

ADVANTAGE OF BEING "GREEN"

Most companies welcome ecological practices only and exclusively because of their concern for the planet. However, ecological practices also mean increased profits and pioneer companies will have a considerable advantage over those left behind because of not having realized it before.

The investment in cutting-edge technology and in professionals with adequate training becomes fundamental, so that the companies of this sector can compete and follow the great international movements of printing companies, or local competitors, presenting pieces of work with high quality at reduced prices and shorter deadlines.

PALAVRS-CHAVE

Indústria Gráfica, Impressão, Offset, Testes de Hipóteses, Estatística, Ambiente, Sustentabilidade, Impactos Ambientais e Resíduos

RESUMO

Um dos assuntos de maior importância e sob discussão na indústria gráfica é a recente procura por produtos e processos com vista a um ambiente sustentável. Actualmente, este tema não pode mais ser ignorado. Não é apenas pela preservação do ambiente que este assunto é importante. A futura rentabilidade das empresas neste sector está directamente ligada ao cumprimento de parâmetros de produção sustentável. A questão é: o que devemos nós fazer para dotar a indústria gráfica de processos ecologicamente sustentáveis?

A resposta assenta numa mudança de hábitos: reduzir resíduos e adquirir essencialmente produtos orgânicos, por exemplo, reduzem o impacto ambiental e incrementam o valor do produto. Neste aspecto, um dos vectores mais importante é treinar adequadamente os colaboradores. Um cuidado especial com as matérias-primas também fará toda a diferença: o uso de revestimentos e laminados recicláveis, assim como gomas com menor índice de componentes voláteis orgânicos, ajudará também a reduzir o impacto ambiental e a incrementar o valorizar o produto final.

A VANTAGEM DE SER "VERDE"

A maioria das empresas está receptiva a práticas ecológicas apenas exclusivamente devido a preocupações ambientais. Todavia, as práticas ecológicas também poderão significar acréscimo dos lucros, já que as empresas pioneiras neste sentido terão vantagens competitivas face às restantes, que, não o fazendo agora, irão ter que o fazer mais tarde.

O investimento em tecnologia de ponta e profissionais com a adequada formação torna-se fundamental, pois só assim as empresas deste sector poderão competir e seguir o percurso das empresas internacionais na área da impressão, ou concorrentes locais, apresentando produtos com elevada qualidade a preços reduzidos, dentro dos prazos de entrega expectáveis.

SYMBOLS AND ABBREVIATIONS

Abbreviations

APA	<i>Associação Portuguesa para o Ambiente</i>
APIGRAF	<i>Associação Portuguesa para a Indústria Gráfica</i>
CEO	Chief Executive Officer
CIE	Consumption of Energy Intensive
CMYK	Cyan Magenta Yellow and Key(black)
CTP	Computer To Plate
DGEG	Directorate General For Energy and Geology
DL	Decree-Law
ECF	Elemental Chlorine Free
ECMR	Energy Consumption Management Regulation
ECRP	Energy Consumption Rationalization Plans
EIC	Energy Intensive Consumer
EICMS	Energy Intensive Consumption Management System
EMAS	Community Eco-Management and Audit Scheme
EMS	Environmental Management Systems
IPAC	Portuguese Institute of Accreditation
IR	Infra Red
ISO	International Organization for Standardization
NECP	National Emission Ceiling Programme
NPER	National Plan for Emission Reduction
PDCA	Plan – Do – Check - Act
PEA	Portuguese Environmental Agency
PRENn	Energy Consumption Rationalization Plans
PTEN	National Plan for Emission Reduction (Portugal)
PVC	Polyvinyl chloride
RGCE	Energy Consumption Management Regulation
RUE	Rational Use of Energy
SPSS	<i>Statistical Package for the Social Sciences</i>
TCF	Total Chlorine Free
UV	Ultraviolet
VOCs	Volatil Organic Compounds

Symbols

χ^2	Chi - Square
ϕ	Phi

Units

kg	Kilograms
€	Euros

TERMS

Population	Results under investigation
Sample	Subset, of the population investigated effectively.
Sample error	Index of variation of the results of a survey. A sampling error of 5% indicates that the result may vary to a further 5% or less 5%.
Population distribution	Degree of homogeneity of population. The less varied the population, the smaller the sample required.
Confidence level	Represents the probability of the collected sample to reflect the population.
Sustainability	Term used to define human actions and activities that seek to meet the current needs of human beings without compromising the future of the next generations.
Community Eco-Management and Audit Scheme (EMAS)	Voluntary mechanism whose purpose is to promote the continuous improvement of the environmental performance of organizations by establishing and implementing environmental management systems, as well as providing relevant information to the public and other interested parties.
Environmental aspect	Within the EMS, such as any element of the organization's activities, products or services that may interact with the environment.
Environmental impact	Any adverse or beneficial change in the environment, resulting wholly or partially from the activities, products or services of the organization
Waste Production	Packaging waste resulting from printing material is produced in storage.
ISO 14000 Environmental Management Systems	International standard that defines the requirements for the establishment and implementation of an Environmental Management System (EMS).

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INTRODUCTION

1.1 Framework

1.2 Objectives

1.3 Structure

1 INTRODUCTION

1.1 Framework

Like every developed country, the population in Portugal is daily faced with the existence of graphic products. Whether at home or in public spaces, all the products we use are printed (from packaging, pieces of clothing to advertising posters on various media and materials), i.e. they derive from the printing industry.

In general, the activity of the printing industry is unknown to the vast majority of people, as well as the weight it has on the country's economy. In Portugal, it is responsible for about 2% of the turnover and a little more of the volume of employment in manufacturing industry. The internet and the phenomenon of globalization are increasingly forcing companies worldwide to compete internationally, where economies of scale play a decisive role.

Nowadays, the conservation and protection of the environment, is a growing concern for the population. The printing industry could not be different.

Sustainable development is being faithfully propagated as a possibility for better living. The deterioration of the environment and public health are also related to industrial pollution, which is becoming more and more aggravated, and consequently, forcing a new posture of the companies, in order to significantly reduce the environmental impacts. The pollution cause, especially those from chemical manufacturers such as inks and varnishes, which are usually more toxic than other types of products, severe impacts on the environment.

On the other hand, society in general is concerned with meeting its needs at the lowest possible price without, however, giving up high levels of quality, allied with ever shorter delivery times. This global scale of delivering quality in relation to ever lower prices and completion of work is forcing companies in the national printing industry to focus on their position as competitors, not only at local but also at global level (Ribeiro, 2004). The investment in cutting-edge technology and in professionals with adequate training become then fundamental, so that the companies of this sector can compete

and follow the great international movements of printing companies, or local competitors, presenting works with high quality at low prices and reduced deadlines.

With the purpose of ascertaining the environmental thinking of the Portuguese printing industry, this piece of work seeks to analyze the level of environmental commitment of these organizations. It aims to determine to each extent is the environment being valued and treated by the majority of these industries, with emphasis on the dimension of the companies here analyzed.

1.2 Objectives

The main goals of this work are the following ones:

- Know how printing companies are faced with the environmental concerns;
- Investigate the mind-set of the main companies' managers regarding environmental concerns;
- Understand the linkage between better managing formation and the ability of the company to adapt itself to the new environmental paradigms;
- Realize the relationship between the companies' dimension and the sustainability policies;
- Comprehend how the purchasers and costs influence the raw materials selection in the printing process;
- Understand how the technologies and products used in this kind of industry can affect the sustainability policies of the companies;
- Realize the global status of the printing industry in terms of sustainability.

1.3 Structure

In order to achieve the desired objectives, methodology of research and data analysis based on a collection will be used by conducting a survey which will describe the general industrial situation in this field of activity. The study will be conducted in mainland Portugal and the islands.

For this purpose, a survey of companies from the sector was initially made and a generic database was built. The database is made up of the company name, respective address and contacts. The next step was to establish the main strands of research and build the survey, trying to cross some questions and confirming the main information required.

The construction of the survey model carried out for the study was built from scratch through SurveyMonkey[®]. Once built, this model was sent to businesses via email, as well as through telephone contact in order to obtain a considerable sample size. The next step was the collection of the Inquiry and data processing. The inquiry was designed to be quick to fill, using direct selection questions, allowing as well a easy further statistical treatment. Data were then systematically processed and critically analyzed. Finally, conclusions were drawn and suggestions for improvement of the sector were made.

LITERATURE REVIEW

2.1 Industry Characterization

2.2 Description of the main production processes

2.3 Types of Media

2.4 Types of print production

2.5 Printing technologies

2.6 Printing Material

2.7 Printing Systems

2.8 Drying Methods

2.9 Finishing Products

2.10 Offset Systems

2.11 Printing Industry Sustainability

2 LITERATURE REVIEW

By producing various essential products for economic and social life, such as books, magazines, newspapers, catalogues, legal documents, packaging, forms, among others, the graphic arts industry affects almost all economic areas, both nationally and internationally.

2.1 Industry characterization

Nowadays, printing industry is one of the main sectors of the manufacturing industry regarding industrialized countries, with high social and economic importance. The world's largest producer in printing market is the United States of America. With regard to the European Union, this industry assumes its importance, being dominated by small and medium enterprises that produce for regional or local market, employing on average less than twenty workers. It is a type of industry that has a high diversity of clients, both in the private and public sectors. The biggest highlight is for publishers, who absorb about half of the total production volume of the printing industry (Silva M. R., 2001). This kind of industry has been under severe pressure to improve its environmental performance. As a result of this pressure, there is significant improvement as regards to the evolution of technology, both in terms of equipment and the use of raw materials.

In order to better characterize the national graphic sector, a brief exposition of data made available by the Yearbook of Graphic Industries and Paper Transformants of 2015, information communicated by APIGRAF, will be made. The printing industries are divided in four statistical groups, as pointed out in table 1.

Table 1 – Statistical groups from printing industry (APIGRAF, 2015)

18110	Newspaper printing
18120	Other printing
18130	Pre-press activities and media products
18140	Binding and related activities

Taking into account the data provided by the yearbook in Portugal, there are about 2286 graphic companies, which employ 16302 workers. This type of industry represents about 929 million euros in global invoicing. On average, each graphic company employs 7.1 employees and invoices 406 thousand euros and has sales of 57 thousand euros per capita. The main outputs of printing industry are presented in table 2.

Table 2 – Main outputs of the Printing Industry (APIGRAF, 2015)

CAE	Main Products and Services
18110 Newspaper printing	Newspapers printed on behalf of publishers or third parties (on a contractual or task basis)
18120 Other printing	Books, music, flyers, flyers, periodicals, albums, diaries, forms, posters, maps, atlases, stamps, paper money, playing cards, smart cards and other printed products (includes advertising gifts, plastic bags, glass, metal, textile) on behalf of publishers or third parties through the use of any printing process (duplicators, stamping machines, photocopiers, thermocopiers, screen printing, etc.) tags, labels, signs, printing, binding and finishing services associated to printing and fast printing services.
18130 Pre-press activities and media products	Composition and photocomposition and other activities related to the processing of data for printing including scanning, optical reading and electronic formatting, preparation of data files for multimedia applications (paper printing, CD-ROM, internet); Digital imposition, production of typographical matrices, including composition of images and metal sheets (for typographical and offset printing); recording of rotogravure cylinders; sheet processing; CTP (Computer To Metal sheet) technology, including photopolymer metal sheets, sheets and molds for stamping or embossing; graphic proofs, artistic work including lithographic stones and prepared wooden blocks; production of transparent and other digital forms of presentation, design of printing products (sketches, mockup, models).
18140 Binding and related activities	Binding and finishing of books, brochures, magazines and catalogues (e.g., folding, gluing, baking, cutting, tanning, gilding and trimming); as well as the activities related to binding and finishing of printed paper and paperboard (e.g. drilling, embossing and gluing)

2.2 Description of the main production processes

The printing process is divided into three main stages: Pre-press, Print and Post-press.

The three processes used in the printing industry are described below.

Pre-press covers a number of procedures to which a particular text or image must be submitted in order to be reproduced through one of the printing methods. It is the chosen printing method that determines how pre-press is processed and it defines the print quality as well (Barbosa, 2005).

The first step is the image processing, so that its final form is the one desired by the client. In most cases, the final image is provided by the customer. However, it may be necessary to assemble several components to obtain the desired final image. The preparation of the image includes the photocomposition and (if applicable) the production of the photolith, through which a model is produced. This model is later used for the production of printing metal sheet (INETI, 2000).

Nowadays, the graphic industries are increasingly turning to computer media, namely Computer To Plate (CTP), thus avoiding the production of photoliths and consequently saving time and resources. The CTP accelerated the pre-printing process, which led many companies to opt for this technique. It allows the metal sheet to be recorded from a digital file, via laser. The file is directly sent to the metal sheet without any need for intermediate processes and without the need for photoliths. Once engraved and revealed, the metal sheets are ready to be used (Barbosa, 2005).

Printing is the main step of the printing industry and consists of the transfer of the image, contained in its form, to a substrate. It is the operation in which the work of a matrix is transposed to a support.

As for Post-press, the third and last stage, it consists of the finishing of printed products, according to their logistics and customer requirements. Finishing operations aim to create, enhance and preserve the tactile and visual qualities of the product, as well as determine its shape and dimensions in order to achieve its purpose. The figure 1 represents the main processes of the printing industry.

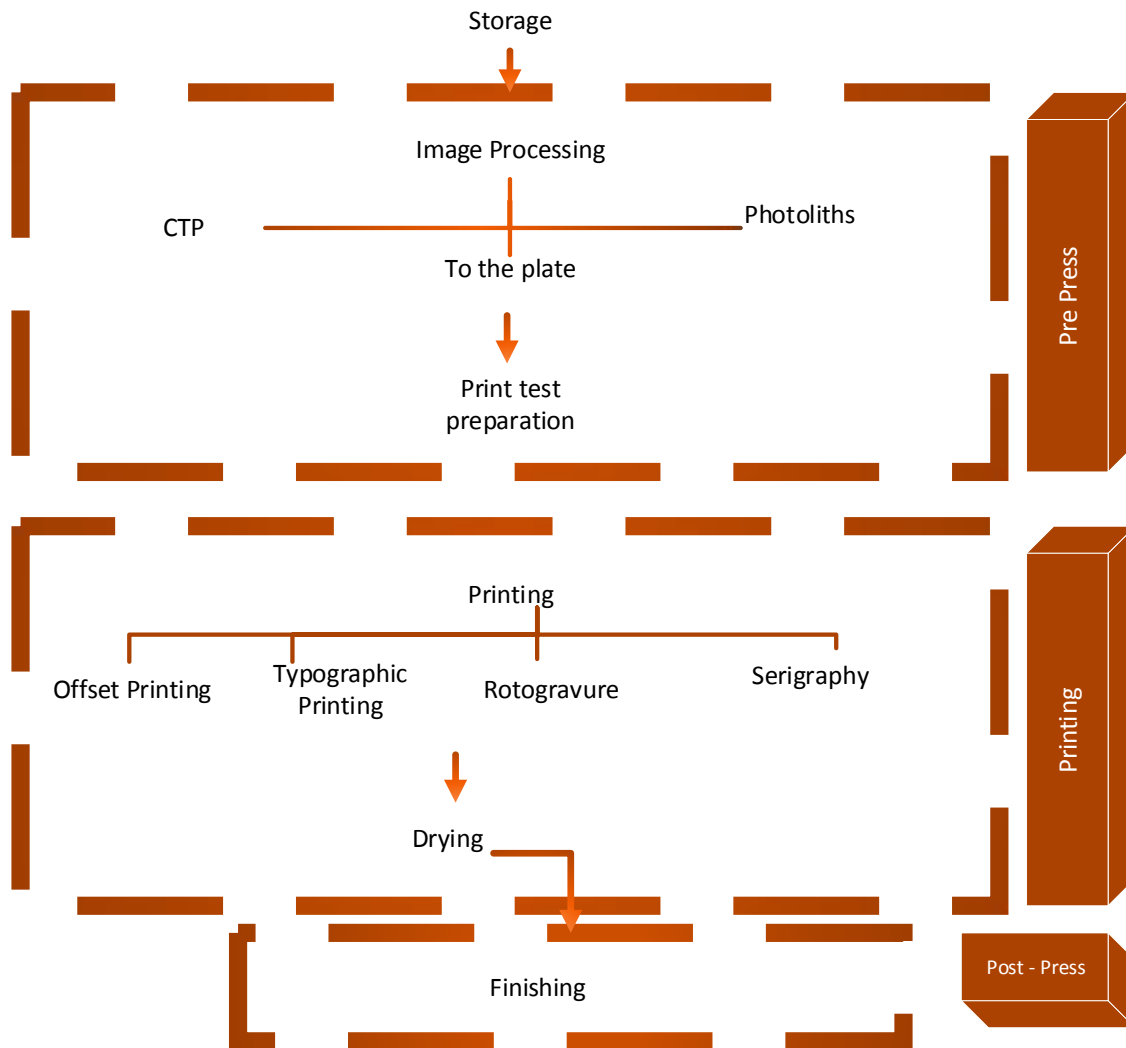


Figure 1 - General diagram of the main processes of the Printing Industry (APA A. P., 2009)

As mentioned above, the use of CTP avoids basic operations which are typical of this type of industry, such as metal surface treatment techniques, using acid and alkaline concentrations and heavy metals. Thus, the environmental impacts associated with these concentrations are avoided.

The flow diagram shown schematically in figure 2, represents a typical printing process in the printing industry, with its inputs and outputs.

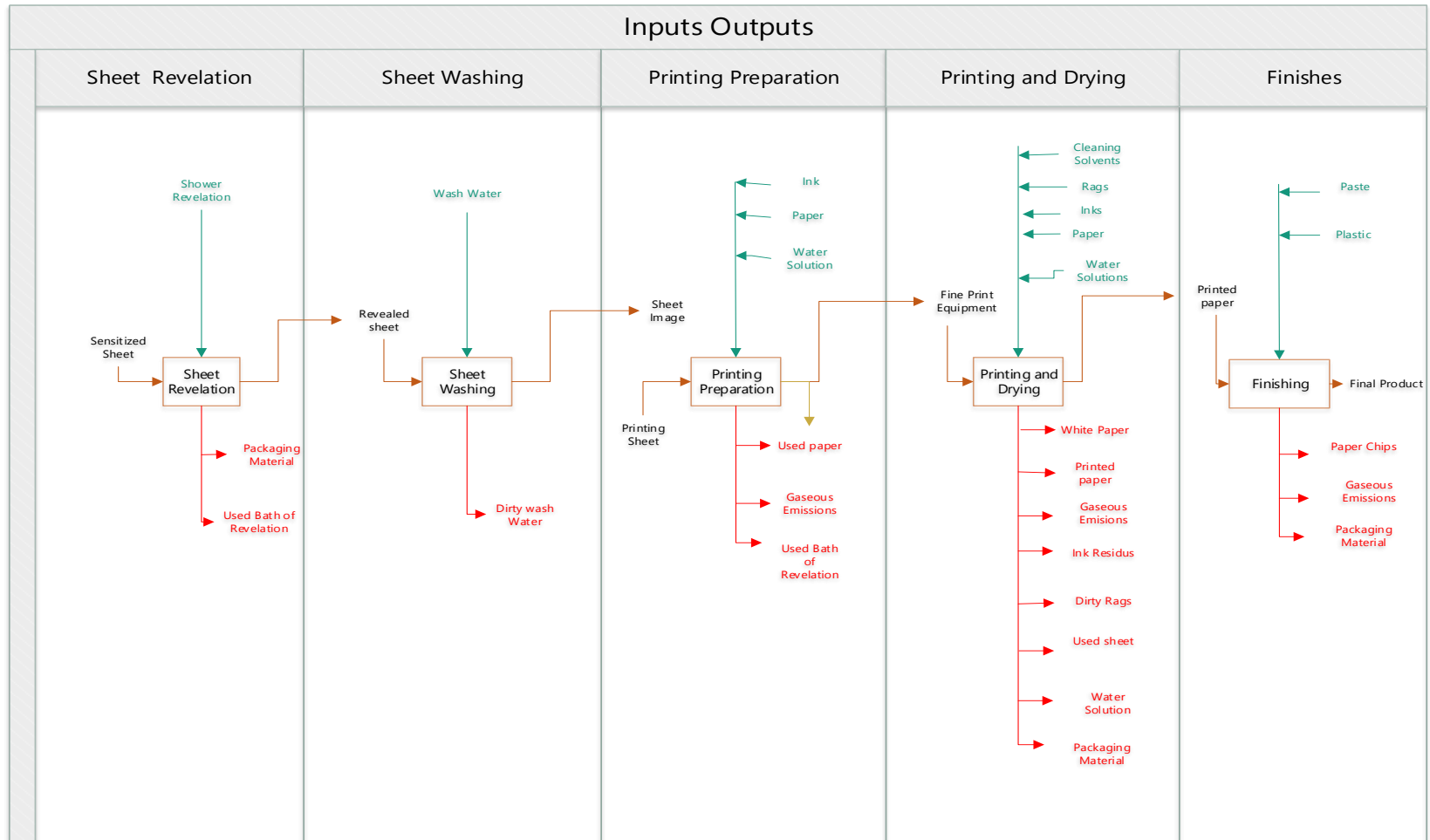


Figure 2 - General diagram of the inputs and outputs of the Printing Industry (APA A. P., 2009; APA A. P., 2009)

The developing of the metal sheet prepares the surface for introducing to receive the printing ink. The photo-sensitive compounds in the sheet are nitrogen compounds. From this process, comes out an acid aqueous solution. The passage of sheet developing varies with the printing process used.

After the sheet has been developed, it is necessary to wash it with water to remove the residues of the bath from its surface. The resulting solution is contaminated with nitrogen compounds.

The next step consists of printing tests to achieve the desired final conditions. Although materials and process equipment (ink, water solution and paper) are already used at this stage, printing is not considered to be started yet, as the conditions are being prepared and optimized. Thus, printed material at this stage is considered a residue and not a final product.

Finally, printing is achieved. Depending on the material to be printed, quantity and quality desired, the printing process may vary.

The drying phase of the ink is almost instantaneous and it occurs soon after its absorption by the substrate. However, certain types of ink and substrates need an ink drying process. This drying process can be performed using various techniques, depending on the type of ink used, namely by applying heat, UV light or another process.

The finishing process consists of a set of very specific post impression operations, which give printed work its final presentation.

All processes described above depend on adequate production planning, including timely provision of raw materials (metal sheets, films, etc.) and other materials and respective storage, as well as quality control of all activities.

Once the production is complete, the final product can be stored or not, followed by shipment of the product (APA A. P., 2009)

2.3 Types of media

The media are instruments that help us to receive and transmit information. They are responsible for providing a large amount of information to society, which takes advantage of these means to be updated about different issues. Throughout the history of mankind five kinds of mass media have been created: the book, the newspaper, the radio, the television and the internet. Next, some media related to the printing industry will be explored.

2.3.1 Books

By the middle of the 15th century, when Gutenberg invented printing with Mobile Lead Types, he unleashed a revolution in book production. This invention allowed that much of the population had the possibility of acquiring further education, culture and information than the one made possible with handwritten books.

Consequently, illiteracy declined in the following centuries. Despite Gutenberg's invention, books continued to be hand-coloured, thus producing colourful volumes of great quality. For more than 500 years, typography was the dominant technology for book printing. Only in the 1970s, when phototypes and lithographic printing became widespread, the printed book becomes a low-cost mass medium. The most efficient production of the processes coupled with the availability of documents at low cost were the main reasons that led to the development of the printed book. Even today, in the age of electronic media, book production has a significant annual growth rate. Germany is one of the largest book markets in the world today. Only China and Great Britain in 1997 produced more titles (Kipphan, 2001).

2.3.2 Newspapers

Today, the newspaper is one of the most significant means of mass communication. It was at the beginning of the 17th century that the first newspapers appeared. Most of these are produced daily and have high circulation. The two most important categories are Daily Newspapers and Weekly Newspapers. There is a noticeable difference

between newspapers and magazines. Newspapers consist of loose sheets of large size. Most of these single sheets are combined during production. A newspaper consists of several sections with different contents called "Journalistic Books". This medium of communication is usually produced on special printing presses. These presses are highly productive, print on uncoated paper and at low cost. Although the traditional newspaper is black and white, modern printers are able to print economically, creating the opportunity to adapt the newspaper's appearance to current expectations (colour photography, colour TV) and thus satisfy the desire of many advertising clients, who want their advertisements to be published in colour. The advertising inserts and advertisements are the ones that finance the production of a newspaper. For this reason, the final consumer price for the newspaper is low (Kipphan, 2001).

2.3.3 Brochures

Simultaneously with the advertising inserts we find every day in newspapers and magazines, the market is quite high with regard to leaflets and product descriptions. Unlike magazines and newspapers, the latter are not published periodically. It is a commercial print job, which presents another significant difference. When compared to the volume of printing of newspapers or magazines it has a low print volume. Nowadays, brochures have better quality than newspapers, usually printed in colour, available on individual folded sheets. The main purpose of brochures is to describe something in particular such as a company or a product. They are used for advertising purposes. Therefore, costs are usually borne by the advertiser rather than the reader.

2.3.4 Forms

The form is an important means of communicating, transmitting and recording information.

"Standardized document, structured according to its specific purpose, having appropriate characteristics and fields, intended to receive, preserve and transmit information, whose postings are necessary to define the nature or to cover any flow of work, from its beginning to its conclusion." (Cury, 2006).

2.4 Types of print production

There are several types of printing that apply different techniques during the process. According to the product needs, the printing system is chosen. As such, it is important that the system is defined at the beginning of the production, in order to avoid problems at the end of the piece of work.

Depending on the type of graphic project to be printed, the correct printing system is chosen. Thus, it is important to define some factors from the beginning of the project, such as the quality and aesthetics of the final material. The type of paper, the drawing, the surface to be applied, among others, are essential to ensure the most adequate final product.

2.4.1 Types

The main types of printing are relief printing, encapsulation printing, planography and permeography. This is divided according to the type of matrix, direct printing (printing directly on paper) or indirect printing (when the matrix transfers the image to a rubber and then to the paper). Relief printing is the most used one. Below, there are the various types of printing and the description of the respective process.

- **Relief printing:** In this type of printing, the matrix/metal sheet has a high relief. The ink is deposited on the matrix/metal sheet. Typography, flexography and letterpress are examples of this type of printing.

- **Encapsulation printing:** Its matrix/metal sheet has got grooves which cause the ink to be deposited inside the matrix/metal sheet. As examples of these are rotogravure and pad printing.

- **Planographic printing:** In this printing process, the matrix/metal sheet is flat. The ink is attracted to the graphic areas due to an adhesive property of the layer constituting the sheet. Examples of this type of printing are Offset and collotypes.

- **Permeographic printing:** In this type of printing, the metal sheet is a screen where the ink crosses the matrix in the areas of graphics, such as Screen Printing.

2.4.2 Typography

It is the type of printing that most resembles the press, which was created by Gutenberg in 1440. It is a high relief matrix bathed in ink, by a distribution system between several rollers. The ink is placed in the inkwell, which bathes the main roller. This irrigates two smaller rollers placed on a rail. When the press containing the matrix rises, the rail slides underneath it and the rollers transfer the ink; when it lowers, it "stamps" the current paper, making thus the printing. Typography is a direct printing system, with slow ink drying, low resistance edition and low-quality colour printing. The figure 3 shows the typography process.

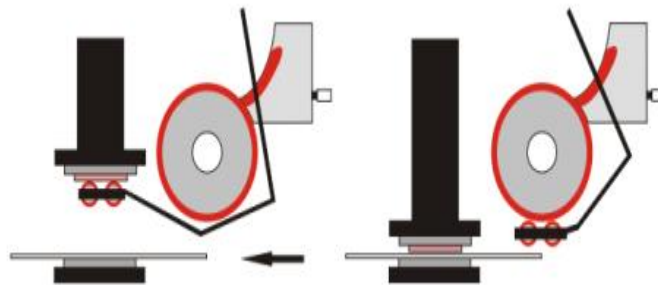


Figure 3 - Typography

2.4.3 Graphic design

For several centuries, the design preserved a conservative nature. It was only used for religious content. The industrial revolution has contributed to an avalanche of printed material. Until the end of the 19th century, the designs were mostly black and white, printed on paper and quite rare. In the 20th century, products such as posters, advertisements, prospects, magazines and books, reached a very high importance and began to be widely spread. All these products began to be distributed with the aim to attract attention. In order to reach this goal, one began to produce an impressive amount of colour and topics through long prints and large formats. The photos and illustrations were soon introduced. The new 20th century Era of design was great. Designers such as Henri de Toulouse-Lautrec, Jules Cheret, Eugène Grasset and A. A. Mucha, created rather surprising artistic and illustrative posters. (Kipphan, 2001)

Design of packaging, graphics and corporate literature, among others, became tasks that could not be solved with artistic fury, but with clear concepts. In 1922 the American William Addison Dwiggins used the professional title of "Graphic Designer" for the first time, because it more accurately described the new type of designer. This was no longer a traditional artist, but someone who specialized in visual communication design and brings together the design tools of typography, illustration, photography and print for the purpose of informing, teaching or influencing.

The development of graphic design was influenced by several aspects. On the one hand, there were the traditionalists, who created the drawings in a traditional way, through the use of tools of traditional artists. And on the other hand, the Methodists that used new ideas of form and content, thus turning this new area of graphic design into a distinctive one. The biggest contribution to this new type of design was "Bauhaus", a design of the German School. (Kipphan, 2001)

2.5 Printing technologies

The twentieth century was when the printing industry underwent its major changes. In the last thirty years, the computer has taken on an extremely important role in the graphic production process with profound effects in companies, whatever the printing system they use. With the computerization of printing machines, the process gained enormous speed. When compared to the 1960s, what took hours to do, then can be executed in less time today.

Whatever the printing system may be, it is fundamental to physically distinguish the areas to be printed from areas not to be printed.

What most characterizes and, therefore, distinguishes each of the so-called conventional printing processes, is the existence of an image conveyor, which may be of aluminium metal sheet in the case of offset, the frame as far as screen printing is concerned or photopolymer metal sheet when it comes to flexography. Each conveyor determines specific requirements regarding the inks to be used, as well as the type of material to be successfully printed.

2.5.1 Printing

There are several printing techniques that can be used. Although most processes rely on printing metal sheet, screen printing is a process commonly used, with the uniqueness of using screens instead of printing metal sheets, which allows the ink to pass to the substrate in the image areas. However, most processes rely on the printing metal sheet.

2.5.2 Flexography

Flexography is the process commonly used to print plastic, paper, cardboard or other absorbent and non-absorbent materials. Because it is a relatively inexpensive process when compared, for example, to rotogravure, it is widely used in low-cost products such as plastic or paper bags, paper napkins, wallpaper, kitchen rolls, plastic packaging for snacks and in several packages of products of great consumption. The figure 4 shows the flexography printing process. (Adhepel)

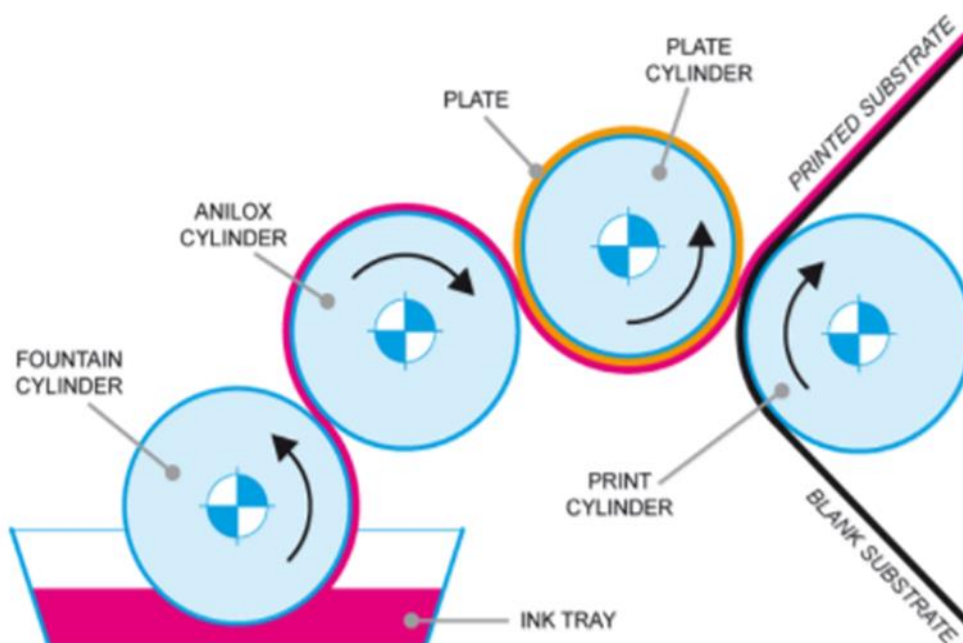


Figure 4 - Example of Flexography printing process (adhepel)

The origin of the process used in flexography is very similar to that of rotary typography; it differs only in the photopolymer metal sheets, also called clichés, because they are more flexible, inks are more fluid and preparation costs are lower. The inks can be solvent based, water based or ultraviolet inks, depending only on the material to be printed. It is the process that, in technological terms, has evolved more in recent years. With recent technological developments, especially with the introduction of shirts digitally printed, flexography ceases to be a cheap printing process for cheap products and becomes a potential competitor to rotogravure. Flexography uses flexible metal sheet with embossing and very fluid inks. The embossing on the metal sheet produces the same effect of typography: the ink ring is more noticeable in plastic than in paper. (Kipphan, 2001)

2.5.3 Printing of engravings

It was in the fifteenth century that the first author artistic impressions occurred. However, prehistoric man already used to engrave to decorate stones and bones and, later, metals. It is the technique with the greatest tradition and the one that has undergone the greatest innovation. As reference in this context are Mantegna, Dürer, Holbein, Lucas Cranach, Piranesi, Rembrandt, Goya, Blake, Gauguin, Munch or, in the twentieth century, Picasso, Miró, Chagall or Tàpies.

In technical terms, the engraving matrix can be printed in two ways: embossed or in depth. The depth is the most common, using a metal, copper or zinc sheet, where through various direct techniques (Ponta Seca, Butil, Black Way, ...) or indirect (Etching, Water-ink, ...) the matrix is created, deepening the dots, lines or smudges of the image. The matrix is dyed in depth, according to the chromatic options and the image transferred, by pressure in the engraving press, to the moistened sheet of paper. The engraving printed in depth is distinguished by the fact that the ink forms a slight relief on the paper. The bevelled edges of the metal sheet that compresses the paper print on the proof a lowered frame, which gives it an additional richness (Serigrafia, 2017).

2.5.4 Lithography/Offset

The invention of lithography in 1798 is credited to the German Aloys Senefelder. Used in the nineteenth century by painters such as Francisco Goya, Honoré Daumier and Édouard Manet, lithography enjoyed its greatest moment at the end of this century, with the colourful prints of Pierre Bonnard, Henri de Toulouse-Lautrec and others. It can be considered one of the most direct means of printing, since the images are executed on a flat surface, such as a paper drawing, or a watercolour. A greasy pencil or paint is used to create the image by directly intervening in the limestone lithographic stone of special characteristics. When a lithograph is ready for printing, a chemical mixture is applied throughout the composition, to ensure retention of the image drawn on the stone. This is then moistened and the water blocks the areas which are not drawn. Lithograph printing is based on the repulsive relationship between fat and water. With a roll, the greasy printing ink is applied and only adheres to the drawn areas, i.e. the white areas are protected by the thin layer of water. The paper is then laid on the stone, pressed, and by manual and even entrainment, the image is transferred (Serigrafia, 2017).

2.5.5 Screen printing

Also known as Silk Screen, Screen Printing consists of the application of a canvas coated with a very thin and resistant fabric, which is stretched and attached to the edges. The image is defined by a recording process, where a coloured emulsion is passed on both sides of the screen. When it dries, the canvas is taken to an enclosed room, where it is placed on a table of light, along with the negative of the art matrix, the photolith. Light will burn the entire emulsion of the screen, making it impermeable. The negative of the matrix prevents the light from burning the emulsion in its corresponding area on the screen. After this process, the screen is washed. Then the water removes the emulsion from this area only, leaving it permeable. As a result, it reveals the space corresponding to the print area. Serigraphic printing occurs as follows: The ink is deposited in the upper corner of the raised screen (Kipphan, 2001);

- The paper to be printed is placed embedded in a record stuck on the table;

- The screen is laid on the table and, with the help of a rubberized (squeegee) blade, the ink is evenly spread over the entire printing area;
- The screen is lifted, the ready print removed and let it dry.

Screen printing is a direct printing system, with slow ink drying and slow print speed, little resistance while printing and low quality in colour printing.

2.6 Printing material

The market offers a variety of papers and films suitable for printing, and use in a variety of applications. Basically, the printing materials are: white matte, glossy and thermal, paper, metal laminates and PVC (white and transparent vinyl).

The quality and reliability of the feed are important guidelines for printing materials. They may vary, depending on the type and size of used printing material, so that the desired result is achieved.

2.6.1 Substrates

It was in the 20th century that paper, the main support of graphic printing, saw its consumption increase on a large scale in industrialized countries. In 1998 the consumption of paper per capita in Portugal was about 96 kg. Although many thought that computerization would reduce the expenses with paper, which was not what happened. In fact, instead of cutting paper costs, computers and their printers led to an exponential increase in paper consumption.

In the United States, in 1997, paper consumption per capita exceeded 300 kilograms a year and the trend continued to grow. With its 96 kilograms per person, Portuguese paper consumption surpassed in 1998 that of countries such as Greece, Mexico, Brazil and China. When choosing paper the most frequently asked questions are: smooth or textured? White or coloured? (Ana Sabino Domingues, 2005/2006)

The main characteristics that the paper must have are (Ana Domingues, 2006):

- **Resistance:** it is one of the most important characteristics for the packaging industry. The paper has to support folds, plastifications, collages over collages and all the manipulation to which the piece will be subjected. The bonding strength of the fibers, especially at the surface, is critical for their ability to resist pressure from the cylinder and the inks during printing.
- **Absorption:** the fibrous structure of the paper contains microscopic openings between fibers that make it absorb liquids and react at room temperature. All paper is absorbent, although some is more than others. The paper absorbability causes a dot gain in the printing process (the ink falls on the paper and expands). Gain is greater if paper is more absorbent. The paper absorption is one of the characteristics that most influences the quality of photographic reproduction and colour. In addition, it requires greater control of the printer because it consumes more ink.
- **pH level:** if the paper presents acid or alkaline properties, affects printing. Recently, some manufacturers have decided to reduce the paper acidity, as they have found that acid paper lasts less. In addition, they tend to neutralize the drying additives of the inks, which causes problems in drying the piece of work.
- **Colour:** most pieces of paper are white, but not all white is the same. To distinguish various types of white, manufacturers have given them names such as bright white, natural white, snow white, or glacier white. It is during the manufacture of paper, which by nature should be brown, that are added chemicals to bleach it, or dyes to give it colour. The base colour of the paper affects the colour of the printed image. This colour will influence the reproduction of the printed colours, since we must count on the sum of the ink colour. It is advisable to ask for printed examples of the paper to see how much the colours change. For a faithful photographic reproduction, the ideal is to print on white paper, which is cheaper and is almost always in stock.
- **Opacity:** it is related to the transparency of the paper. When you print on one side of the paper, you cannot see the image on the back side and much worse

on the next page. The opacity results from the thickness, the paper weight, the fibre type, the additives and the coating type. Due to ink residues, recycled paper is usually opaquer than papers made from virgin fibres.

- **Brightness:** it is the amount of light reflected by the paper surface and it will affect the contrast and brightness of the printed image. It results from the type of pulp, the amount of chemicals used to bleach it and the coating on its surface. When reflecting the light, coated papers make reading more difficult and tire the eyes. The graphics prefer to print on glossy paper because it is easier to achieve the desired colours, easier to print and faster to dry.
- **Coating:** The paper coating refers to its surface. It is in papermaking that you define how your surface will be, i.e. how it will look, how it will feel to the touch and how its functionality on the printer will be. Chemicals are used in the process of paper coating in order to make its surface smoother and softer. The more coating layers the paper carries, the softer the surface will be and the easier it will be to print. This way the paper accepts the ink better, it goes through the printer easily, and the ink coverage is even more effective. Coated paper is covered, and it can be glossy, semi-glossy or matte. The chemical process of the paper coating is extremely polluting and makes it impossible to recycle it.

Usually, ecological concerns about paper are centred on recycled paper, the apparently simple and conscious choice. But, there are still other areas of environmental concern, until the end of life of the printed object: energy consumption, pollution, waste and the use of land to create raw material, as well as the possible rejection of the printed product. About 90% of the world's paper supply is derived from wood pulp. Although wood is a renewable resource, forests are not managed in a sustainable way. In the Portuguese case, the intensive cultivation of eucalyptus has radically altered local ecology. Pesticides used to grow forests specifically for paper, are highly polluting and harmful. In so many cases, old forests are thrown down, dislodging entire ecosystems that take decades to recover. From a global perspective, there is also the problem of deforestation of tropical areas, which contributes to the maintenance of the fragile terrestrial balance.

Paper can be made from many other raw materials besides wood. The essential ingredient is cellulose, and this can be found in any plant. It can use (Ana Domingues, 2006):

- leaf fibres: esparto, sisal, and marilla;
- seed fibres: cotton;
- weed fibres: straw, corn sticks, bamboo and sugarcane bagasse;
- other fibres: from stamens of flax, cannabis and jute.

Cotton can produce high quality papers and it is much used in fine arts. There is also a growing demand for papers made from the waste of fruits and vegetables, such as banana peels. Wood is still the most economical raw material for papermaking, and it is a good environmental hypothesis if, and only if, tree cultivation is carefully planned and logging is carefully controlled. There is still a large part of papers that are made from the blending of various types of vegetable fibres, depending on its expected characteristics.

Wood can be made into paper according to two main processes. Each one of these result in different pulps, which in turn origins different types of paper. In the first process, the mechanical one, wood is only smashed to form a pulp, and the whole tree is used. The resulting pulp has a high fibre content, the remainder being lignite, a hardener that holds the fibres together in the tree. The presence of this lignite, which is sensitive to light, means that the resulting paper will darken and become brownish. The mechanical pulp results in cheap paper with good opacity, with high thickness, but its surface is little soft and little bright. These pieces of paper eventually discolour over time, have little strength and durability, and are therefore not suitable for quality printing. This type of paper is thus used in more ephemeral jobs, such as for newspaper printing or for carton packaging. This mechanical process consumes high levels of energy. The alternative is a chemical process, which involves treating wood chips with chemicals that separate its resins. Chemically, it is easier to separate the fibres from one another and remove the impurities. Since mechanical force is not used in the chemical process, it is easier to keep the fibres whole and long, resulting in a stronger, more coloured and brighter paper. Chemical pulp papers are more expensive than mechanical pulp or mechanical/chemical pulp papers. Lignite is separated and

used as fuel. Only 50% of the tree turns into pulp. There are still several types of combinations of mechanical/chemical processes, which, in some cases, improve surface smoothness, as well as porosity. It also reduces the possibility of discolouration over time. On the other hand, in some cases, opacity decreases and production costs become higher.

The next step is to add chemicals to bleach, purify and stabilize the pulp without damaging the fibres. This process can be done once or in phases. In the process of making paper, a variety of chemicals is used. The most criticized and most harmful to the environment is chlorine, used in this phase of bleaching pulp. Chlorine is toxic to aquatic organisms, and is known to affect fertility. Instead of chlorine, other little or no harmful substances may be used: oxygen and hydrogen peroxide. In some countries, the use of chlorine is banned because of the problems it can cause in the environment, so the use of other bleaching agents has been increasing. There is also a new process that uses ozone and peroxide. The whiteness quality of this paper is excellent and therefore there is no need to use chlorine at this stage of the process. There are two types of paper that do not use chlorine in their manufacture: ECF (Elemental Chlorine-Free) and TCF (Total Chlorine-Free). ECFs use chlorine dioxide instead of chlorine. This results in lower emissions, especially if more modern processes are used; it almost totally eliminates the dioxins present in the water produced in the bleaching process. In TCF, no chlorine product is used, but rather oxygen, ozone or peroxide. Whenever possible, it is environmentally preferable. (Ana Domingues, 2006)

2.6.2 Inks

Each printing process requires different inks. In general, all inks are composed of pigments, resin, solvents or other additives, which drive the drying or provide the necessary properties of the ink. Typography inks usually have a moderate viscosity, although superior to offset inks, in order to be able to remain on the embossing surface of the metal sheet, without draining into the non-imaging zone. Although pasty, the ink is worked by a series of rollers that transform it into a thin and even jet of ink, before passing to the paper.

The concentration of pigments is lower than in offset ink. Most flat printing inks, such as in typography, consist of pigments and oil-based drying vehicles, that dry by oxidation. They may also contain special resins and other components that provide characteristics such as brightness and strength. For rotary printing, the inks dry through penetration, evaporation or precipitation.

Offset inks are formulated to print on flat surfaces, bearing in mind that water and grease do not mix. They are very strong in colour values to compensate for the small amount applied. The average of ink transmitted to the paper is about half from that in typography.

Rotogravure inks are very fluid, drying very fast and they must have the required viscosity to enter the points recorded in the cylinder. They usually dry by the evaporation of the solvent in the ink, with or without the use of heat. A wide variety of solvents are used, depending on the material to be printed. Most inks are very volatile and can cause fires or explosions if not treated properly.

Flexo inks are very fluid, they dry quickly and its viscosity is similar to rotogravure inks. They are used to print almost any type of material, from wallpaper, carpets, cellophane or any type of plastics. They consist of dyes, which may be pigments or simply soluble dyes, usually based on water, alcohol or other solvents. Alcohol-based inks are the most frequent and dry through evaporation. Water-based inks are the most economical and dry through evaporation and absorption on paper. These inks are exclusively used in newspaper printing because of their poor quality.

The drying of screen printing inks is usually oil-based. It uses solvents, which should not evaporate quickly.

Offset waterless inks are more oil-based inks than conventional ones, which means less dot gain and more lines per inch.

Ultra-Bright inks contain a high amount of varnish, which gives it a shiny appearance after drying. The less absorbent the paper, the brighter it will be.

Metallic inks consist of the mixing of metallic powders with varnish that give the ink a metallic appearance. The metal powder and the vehicle for preparing the metallic ink is mixed shortly before use, since most of the metallic inks rapidly oxidize after mixing. They take longer to dry than normal inks.

Fluorescent inks were initially limited to screen printing. A new type of pigments, thinner and stronger, have allowed this type of colours to be printed also in offset, typography and rotogravure.

2.6.3 Varnishes

The various types of varnishes are used as coatings to provide more gloss or to protect the printed inks. There is a wide variety of varnishes: ultraviolet, acrylic, machine or screen printing. Machine varnish is the most common because it works as one colour more. It is placed in an offset printing machine so that there is minimal ink protection and the danger of dirty is avoided. This varnish is vegetal based and it dries naturally. The ultraviolet varnish has a synthetic base, which reacts to ultraviolet light, giving a thicker finish than the previous one. Any varnish can be matte or glossy, and it is possible to make various combinations between various types of varnishes. (Kipphan, 2001)

2.7 Printing systems

When developing a graphic project, it is important to consider printing quality, so that the layout is valued and the message is transmitted efficiently. However, before starting the development of the project, it is essential to clarify the most appropriate printing system, taking into account the type of paper, the colours and finishing that are used. Printing processes are defined by how the graphics are transferred to the paper and are sorted in direct and indirect processes (APIGRAF, 2015).

2.7.1 General structure

Table 3 presents the main printing systems, as well as the characteristics of each one.

Table 3 – Printing systems and characteristics (APIGRAF, 2015)

Printing Systems	Characteristics
Digital	<p>If you are talking about small numbers of prints (short runs) the strengths of digital printing are its quickness and low cost. Its weaknesses are limitations concerning the variety of substrates and quality, whose criterion is always quite subjective.</p> <p>Digital printing systems mean more than just printing. They represent a new way of creating and communicating. With tighter deadlines and reduced print runs, digital printing has been gaining more and more adepts, especially in advertising.</p> <p>Two of the great advantages of digital printing are the possibility of being able to directly test the machine and make colour corrections immediately, if necessary.</p> <p>Another advantage is that toner and inks used in digital printing almost automatically dry out in after printing, which is not the case in conventional processes.</p> <p>There are several digital printing systems and its choice depends on the job in question.</p>
Electrophotography and Digital Offset	<p>Electrophotographic printing and digital offset make short runs possible, what would be too expensive in conventional offset.</p> <p>There are in the market some brands of digital printers whose base is the electrophotographic process, however they differ in some aspects.</p>
Inkjet	<p>This process prints the image through small jets of liquid ink. With reduced resolution, these ink jets are perfectly visible, like an array of dots. With high resolution this matrix is no longer visible, although it is possible to see that the outline of the letters is irregular by using a device to count lines. At high resolution, photo reproduction reaches high quality.</p> <p>Inkjet technology comprises several systems, which are most suitable for large format printing.</p>
Electrostatics	<p>It is a variant process of electrophotographic printing. It is widely used for large format printing. Once printed on electrostatic paper, it is then transferred to the most diverse types of materials, such as fabric, vinyl or other fabrics, and printed by toner.</p>
Sublimation	<p>It is the direct transformation from solid to gaseous state without intervention of a liquid state.</p> <p>The process of sublimation derives from thermal wax printing, in which the coloured wax spots would be melt at high temperatures and adhered to the printing support.</p>
Computer To Plate	<p>This process is based on the conventional offset system, but it dispenses the photoliths and the process of developing the plate is done digitally in the machine that will print the work. The sheet is made of polyester and it is coated with a layer of silicone, which serves to distinguish the printing areas from non-printing areas, since it is a non- wet printing process.</p> <p>Before starting to print, laser beams are digitally projected onto the metal sheet. These cause small cavities in the silicone layer and form the image. The ink adheres to these cavities and it is repelled by areas where silicone still exists. Unlike electrophotographic printing, these metal sheets cannot be reloaded into each print, nor altered after being recorded, which makes this process not suitable for custom printing.</p> <p>The metal sheets are automatically loaded and machine cleaning is also automatic.</p> <p>The machine contains thirty-five metal sheets in stock and it automatically covers after the respective cylinder after finishing printing one piece. Which means it can immediately switch to another one.</p>

2.8 Drying methods

In most cases, ink drying is almost instantaneous and occurs soon after absorption by the substrate. However, for a certain type of substrates and paints, an ink drying process is required. This process can be carried out by different methods: application of heat, UV light or other processes, depending on the type of ink. The printing ink solidifies during the course of this process, creating a prerequisite for a reliable printing finish and, later, the use of the printed products. Depending on the accumulation of paint, drying is effected by chemical reaction (oxidation or polymerization) or by physical processes (penetration, evaporation) or by a combination of both. Figures 5 and 6 show an overview of the drying methods and their main fields of application.

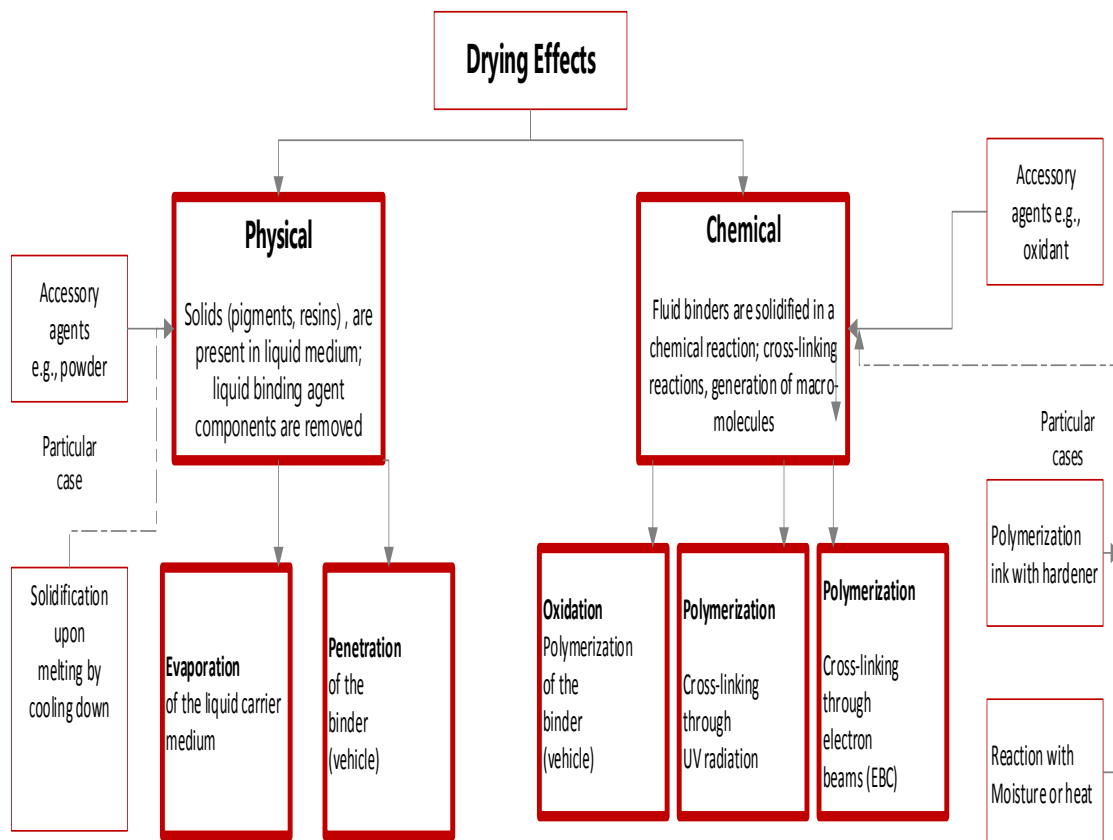


Figure 5 - Overview of drying types and effects (Kipphan, 2001)

Table 4 - Overview of drying methods, drying effects and fields of application (Kipphan, 2001)

Drying Methods	Drying Effects						Use (mainly)
	Evaporation	Penetration	Oxidation	Polymerization	Solidification	Two-component polymerization	
Hot-air drying	X	x	(x)			x (Polymerization is accelerated)	Web offset (heatset) Gravure printing Flexo printing Screen printing Ink jet Dispersion varnish (water-based)
IR drying		X	(x)			x (Polymerization is accelerated)	Sheet offset
UV drying		(x)		X			Flexo printing Sheet offset Screen printing Varnishes
Excimer				X			Flexo printing
EBC				X			Web offset
Cooling (Hotmelt inks)					X		Ink jet

Symbols: X main effect; x, (x) further effects of less importance

Figure 6 shows an offset press with several integrated drying systems. For an ideal drying process, the drying methods for paints and varnishes require different systems. Thus, it may be useful to install an IR and a UV dryer, to ensure variable printer capacity.

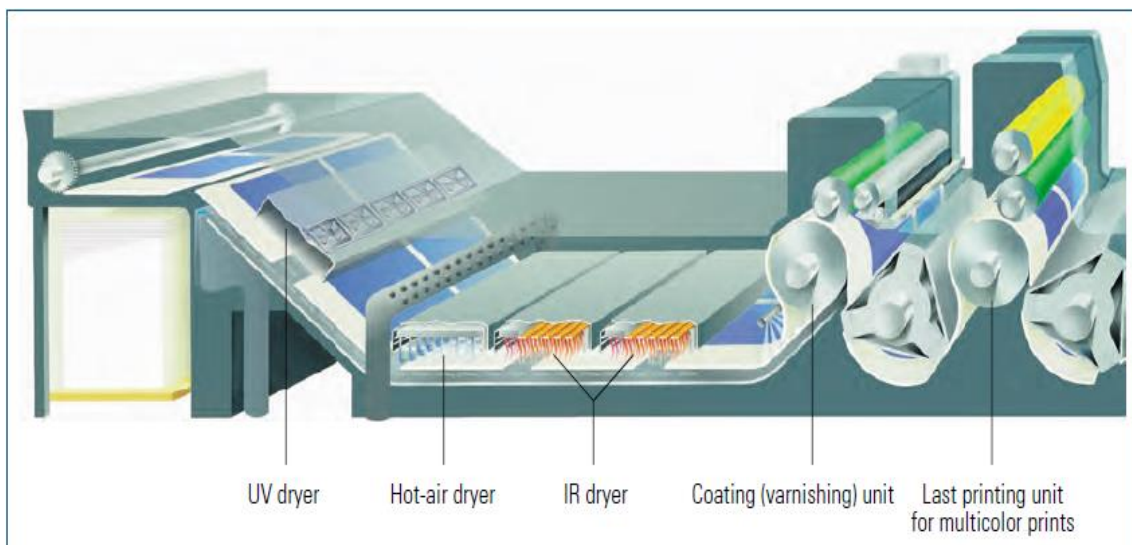


Figure 6 - Installation of different types of drying systems in a sheet offset press (Kipphan, 2001)

According to the drying properties, the structure of printing inks must meet two opposing requirements (Kipphan, 2001):

- no drying on the rollers during press operation or low-down periods,
- fast drying and anchoring on the substrate after printing.

The following factors are most crucial to the drying properties of printing inks:

- the composition of the paint, in particular with regard to the vehicle used, the conveyor and relevant additives;
- characteristics of the material to be printed (penetration capacity, etc.);
- printing conditions (amount of transferred ink, stack height, print speed);
- climatic conditions (humidity, room temperature);
- construction of the dryer (air flow on the paint surface, reaction period, type of power supply, etc.);
- Temperature is a decisive factor - in general, higher temperatures are beneficial:
 - the rate of polymerization is accelerated;
 - the viscosity of the ink is reduced to support penetration;
 - there is more rapid evaporation of the solvents.

The degree of bonding between the inks and the substrate varies after the drying process is finished.

2.8.1 Physical drying (Absorption)

Absorption depends on the viscosity of the carrier of the printing ink, the carrier (binder) and the absorbability of the substrate. The printing ink components begin to penetrate by transferring the ink to the paper and are sucked into the paper by paper capillaries.

Of course, the penetration into the substrate depends on the substrate rate of absorption. This speed is determined by the porosity and quality of the wetting agent. Porosity, in turn, is characterized by the number of pores, area and pore diameter. If the absorption capacity is too high, the ink loses gloss and abrasion resistance,

resulting in dull pigments. Thus, high density paper is generally the ideal substrate for fine printing and drying (for example, art paper).

In newspaper printing, drying is affected by mere penetration (coldset). The penetration process is performed in a fraction of a second and the drying process is complete. Generally, the printing inks used in newspaper printing do not contain drying oils (mineral oils). When printing inks, whose vehicles consist of drying oils, are used, oxidation chemical drying is triggered after penetration. (Kipphan, 2001)

2.8.1.1 Infrared Drying

In this drying method, penetration of the printing ink is faster if viscosity is low, with increasing temperature. The film of transferred ink can be heated together with the substrate using an IR radiation source. The IR drying effect on offset printing can be described as follows (Kipphan, 2001):

- Reduced viscosity of ink oils by heating and faster penetration;
- Oxidation in the hot pile is faster;
- Oxidation is accelerated by lower proportions of water in the applied ink layer.

The process of chemical drying (oxidation) after the physical drying process is also accelerated by a rising temperature.

The above processes are detectable in all types of offset ink. The optimal effect of an IR radiator is achieved if maximum radiator energy and maximum ink penetration (or varnish) match.

2.8.1.2 Evaporation

Evaporation drying method is used when the printing ink consists of various components, such as resins, pigments and solvents. This method occurs as follows (Kipphan, 2001):

- Conversion of liquid (solvent) in vapor state and formation of generated steam or steam-laden air: the solvent evaporates when a printing ink is

dried by evaporation. The drying process is determined by the heat transfer on the surface of the printing ink.

The surface temperature and, above all, the air velocity along the surface of the substrate, as well as the partial pressure difference, are the main parameters for the drying rate.

2.8.1.3 Operational Problems

In general, physical drying is affected by several parameters. The following examples will illustrate it (Ange):

- Drying becomes more critical if penetration slows down, or if ink application increases in the image, or if substrate weight increases;
- Bubbles can occur with heavy weights, and heavily satin papers. High ink application can cause such high temperatures - particularly with short dryers - that water vapour divides paper, which in turn results in bubbles and a large number of litter. The temperature of the dryer and the printing speed is then reduced;
- Drying depends on the speed at which the paper passes through the dryer. The temperature of the dryer should be adjusted according to the weight of the paper: the higher the weight, the higher the temperature. Drying systems require considerable space. Due to dehydration, paper net/grid can become fragile and wavy, and start to shrink. Printing finishes becomes more and more difficult.

2.9 Finishing Products

The step after printing is the completion of the product. At this stage, printed plans gain greater quality, brilliance and nobility. With the help of machines, but also with specialized labour, paper is cut, creased, folded, glued, etc. These are some processes that usually occur in the finishing part:

Plastification

It consists of the application of glossy or matte film on the paper, which constitutes an extra protection factor. There is the possibility of using patterns or textures (figure 7).

Binding

The most common form of bookbinding is the hot and/or stitched bonding system. In addition to this, there is also the ring wire and the spiral, common in notebooks, as well as stitching at two wire points, applicable to magazines and catalogues (figure 8).

Cut and folding

Cut and folding use a moulded blade in a wood matrix. These blades can have sharp edges, or folded with rounded edges. Paper cutting is done under pressure on specific machines (figure 9).

Varnishes

Varnishes can be applied all over the paper surface or in a more localized way (known as backing varnish). There are varnishes with a glossy or matte finish, and textured variants with scents, etc. This process can be done in offset machines or specific machines, depending on the chosen option (europress, 2017) (figure 10).



Figure 7 - Plastification



Figure 8 - Binding



Figure 9 - Cut and Folding



Figure 10 - Varnishes

2.10 Offset systems

One of the most used forms for printing is the offset system. This system is used for large and medium quantity prints, since it offers good quality and it is done very fast. Nowadays, it is the most used process in the printing industry. Besides guaranteeing

quality for large and medium quantity prints, it prints on virtually all paper types, as well on some types of plastics (especially polystyrene).

It is an indirect printing system, where the form is a metal sheet engraved with an image. After passing through the ink, this image is transferred to an intermediate cylinder, known as blanket and it is transferred to the substrate through it.

Offset is ideal for large printing because paper runs through the machine and it does not require any human intervention while the process is done. Although there is no human intervention while the process takes place, it is necessary, since the machine needs adjustments during printing, whether to adjust the amount of ink and water or when a print has more than one colour.

2.10.1 Basic principles

The functioning of the offset process is as follows (figure 11):

First, a metal sheet is prepared to become photosensitive. The area that is shielded from the light ends up attracting grease - in this case the ink - while the rest attracts only water - which does not reach the paper.

Secondly, the metal sheet is attached to a cylinder. This cylinder will roll through a smaller one that contains the ink - which may be cyan, magenta, yellow or black. The ink will "paste" into the image, while the rest will be "white".

Thirdly, a cylinder with a rubber blanket rolls over the first cylinder (with the metal sheet already painted). The blanket will absorb the ink better and provide better friction to the paper. The image is now printed on the blanket.

Fourthly, the paper passes between the cylinder with the blanket and another cylinder that will make pressure on it. Thus, the image is transferred from blanket to paper. This means the sheet prints on the blanket, which on its turn prints on the paper.

The metal sheets can be designed by photogravure using photoliths or by digital recording. In the production by photogravure, the virgin aluminium sheet is placed in

the recorder, or contact press under the photolith. The photolith is like a positive transparency of one of the four colours (Cyan Magenta Yellow and Key(black)CMYK) (Kipphan, 2001).

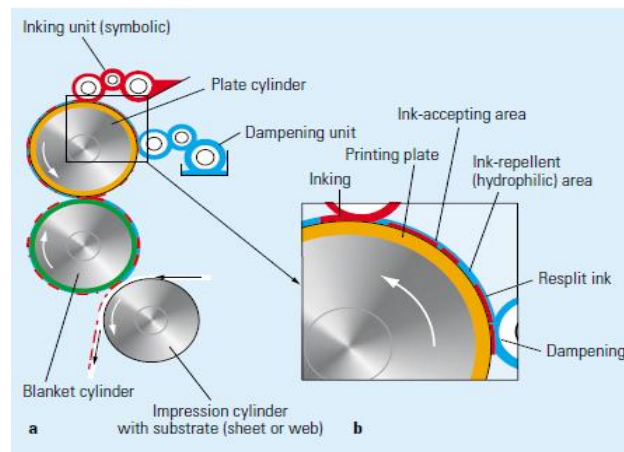


Figure 11 - Offset printing (lithography) (Kipphan, 2001)

The photolith, adhered to the metal sheet by vacuum, is exposed to light for some time. Light allows photolithographic images to be printed on the metal sheet - this step is called recording or sensitization. In this step, the light "softens" the emulsion in the metal sheet. Anything that has been exposed to light will begin to attract moisture, while the area that has not been exposed "hardens" and begins to attract grease (in this case, the ink). The metal sheet is then rinsed with specific chemicals that will react with the areas exposed to light, as well as with the unexposed areas. This is called the revelation stage.

In offset printing, the printers can be flat or rotating. This means that you can use single (flat) sheets or paper reels (rotary). The reel system, for example, is used in the newspaper industry because it is much faster - an average of 30,000 copies per hour - but the quality is lower than in flat offset printers. These are more often used to print posters, books, leaflets, folders, etc. There are also high-quality rotary printers available only on very large graphics and used mainly for high-print magazine printing (Kipphan, 2001).

2.11 Printing industry sustainability

Sustainability is the term used to define human actions and activities that seek to meet the current needs of human beings without compromising the future of the next generations. It is directly related to economic and material development without harming the environment, using natural resources in an intelligent way, so that they can exist in the future. (Sustentabilidade, 2014)

Figure 12 shows the best practices to be followed in the printing industry in order to improve sustainability at various levels, from compliance with legal requirements, to the implementation of environmental management systems and cleaner production, to the assimilation of sustainability to the day-to-day of the company.



Figure 12 - Good practices for sustainability Printing industry (Sustentabilidade, 2014)

2.11.1 Legislation

The existence of a political and legislative framework, both nationally and internationally, reveals a determining factor for regulating the behaviour of economic agents, especially in relation to environmental issues.

It is essential that companies, in addition to environmental awareness within their organization, have a credible knowledge of the political and legislative framework in force around printing industries.

A legal framework that can reconcile human activity and environmental protection is essential for any country that wants to preserve its natural resources and values for future generations, in balance with the development of competitiveness objectives, which are unavoidable in today's societies.

The National Government addresses environmental problems, based on the principle of prevention and its inherent Principle of Responsibility.

In a society where the economic and social decision is essentially based on an overall cost-benefit and cost-effectiveness calculation, the mechanisms of environmental responsibility represent ideal instruments for the National Government to condition and control undesirable behaviour by the involved economic agents (Ange).

2.11.1.1 Water legislation

Currently, pressure on water resources is increasing, which results into a greater volume of water abstracted for different purposes. Besides the hydrological regime of rivers becomes more artificial, aquifers drain themselves and pollutant load from sporadic and diffuse origin increases. Given this situation, and in response to this intensification and increasing awareness of the population to the inherent risk, a value is conferred in individual and collective terms given the need to protect biological resources and ecosystems. The inherent policy must assume a legal expression, so that it is understood and considered in the decision making of public and private interests of authorized environmental acts. The issue of water management relates to the definition of the conditions under which the respective economic operators use it, as well as its subsequent monitoring. (Ange)

2.11.1.2 Waste

The number of regulation in force in the area of the environment, and in particular in the area of waste, is numerous. Man, increasingly aware of the importance of minimizing production and its sustainable management, has extended the existing legislative framework for waste management.

Regulation seeks to reflect the notion of self-sufficiency, the principle of prevention and the prevalence of waste recovery on disposal. In the context of recovery, preference was established for reuse over recycling and recycling over energy recovery. The need to reduce the production of waste and ensure its sustainable management, contributes to the shared responsibility of waste management, from the producer of the waste to the consumer of the goods.

Waste planning and management, encompassing all their types of waste and its different origins, are the objectives of policies in this field of the environment, also assuming an important role of transversal character by the incidence in the preservation of the natural resources and in other environmental strategies.

Decree-Law 178/2006 of 5th September - Waste Framework Law -, which created the National Waste Authority, comprises in its legislative framework its proper management, which contributes to the preservation of natural resources both at prevention as at recycling and recovery. At the same time this reflects the importance of this sector in its environmental and economic aspects. It also foresees challenges for policy-makers and all the agents in the chain of management, from public administration to economic operators and citizens, while producers of waste and other agents which are indispensable for the pursuit of these policies. (Ange)

2.11.1.3 Air legislation

In terms of Community policy, in the last decades, improving air quality has been one of the great achievements as far as the environment is concerned. Despite the undertaken actions, there are still problems that persist and need to be solved. Portugal has established a Plan of Action for Air Quality, which allows to program measures/actions to ensure that air quality is maintained within the legally recommended levels.

The updating and adaptation of the existing legislation to national reality concerning reduction of emissions, together with the National Emission Ceilings Programme (NECP) and the National Plan for Emission Reduction (NPER) of the Large Combustion Plants, lead to the taking of actions/measures, which are necessary to implement a way of fighting air pollution in a coherent and harmonized way. (Ange)

2.11.1.4 Energy Legislation

By Rational Use of Energy (RUE) is meant the set of actions and measures that aims the best use of energy. This factor is more and more important to be considered in energy saving and cost reduction, both in the domestic sector as well as in the service and industrial sectors.

Decree-Law No. 71/2008 of 15 April 2008 regulates the new Energy Intensive Consumption Management System (EICMS), which replaces the Energy Consumption Management Regulation (RGCE, 1983). The EICMS aims to promote energy efficiency and monitor the energy consumption of energy intensive consumer installations (EIC). To that end, it provides for EIC installations to conduct energy audits on a regular basis, which address the conditions for energy use and promote increased energy efficiency, including the use of renewable energy sources. It also provides for the elaboration and execution of Energy Consumption Rationalization Plans (ECRP), establishing rationalization agreements of these consumptions with the Directorate-General for Energy and Geology (DGEG), which include minimum energy efficiency objectives, associated with their compliance in obtaining incentives by the operators (entities that operate the EIC facilities). (Ange).

2.11.2 Environmental management system

Once legal requirements have been met, the next step to improve sustainability in the printing industry is to implement management systems and obtain certifications. There are different management systems, all of them seek to manage and improve the organization's policies, processes and procedures. As reference for implementing an environmental management system, there are the following standards:

- EMAS
- ISO 14000
- ISO 9001
- Portuguese System of Sustainable Forest Certification and Forest Stewardship Council.

All of the above systems have a similar structure and apply the PDCA (Plan – Do – Check - Act) continuous improvement cycle, detailed below. (Sustentabilidade, 2014) (CTP, 2016)

- **Plan:** it establishes the objectives and necessary processes to present results according to the client's requirements and the policies of the organization; it defines the main aspects and/or impacts related to the company's activities and the applicable legal requirements; it establishes a management program.
- **Do:** it defines the structure of the plan and the responsibility of its agents; it promotes training, awareness and employees training; it develops a communication plan; it documents the implemented measures; it establishes a form of operational control and emergency preparation measures.
- **Check:** it monitors and measures processes and products according to policies, objectives and requirements, as well as reports the results; verifies compliance with the standard specified requirements; it documents nonconformities and solves them; it establishes corrective and preventive actions; it records the actions and prepares internal audits.
- **Act:** it takes actions to continually improve process performance.

2.11.2.1 ISO 9001 – Quality management system

The main benefits of implementing the quality standard are (Sustainability, 2014):

- Improvement of the company internal organization, by clearly defining responsibilities;
- Employee and co-workers' awareness and involvement towards quality improvement;
- Reduction of scrap, waste and reclamation, allowing productivity improvement and lower costs;
- Customer satisfaction through prevention of nonconformities;
- Highest value attributed to the product;
- Improvement of the company image.

2.11.2.2 ISO14000 – Environmental management system

International standard that defines the requirements for the establishment and implementation of an Environmental Management System (EMS). The standard requires companies to take responsibility for pollution prevention and continuous improvement as part of their business management cycle. Applying the standard is a way to control costs, reduce risk, and improve business performance.

The main benefits of implementing an EMS and consequent system certification are (Sustainability, 2014):

- Improvement of the internal organization of the company, by clearly defining responsibilities;
- Meeting customers' environmental expectations;
- Achievement of new markets;
- Good relationship with the community;
- Minimization in waste generation;
- Conservation of materials and energy;
- Process improvement and productivity increase;
- Better environmental performance.

2.11.2.3 Community Eco-Management and Audit Scheme (EMAS)

The Community Eco-Management and Audit Scheme (EMAS) is a voluntary mechanism whose purpose is to promote the continuous improvement of the environmental performance of organizations by establishing and implementing environmental management systems, as well as providing relevant information to the public and other interested parties.

All these advantages together give EMAS three distinct characteristics (figure13):

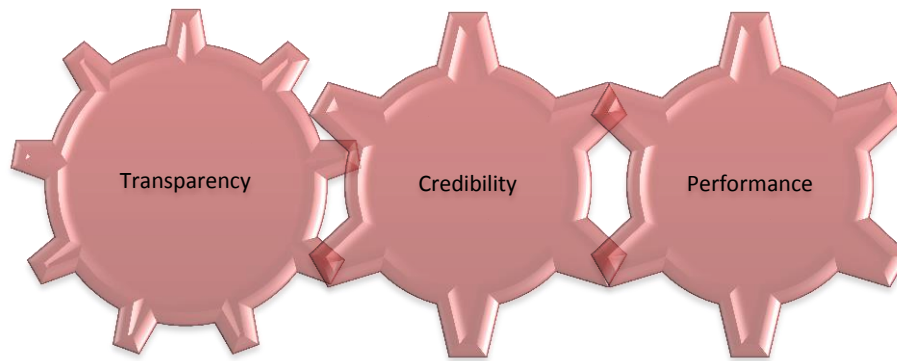


Figure 13 – EMAS Characteristics (APA, 2017)

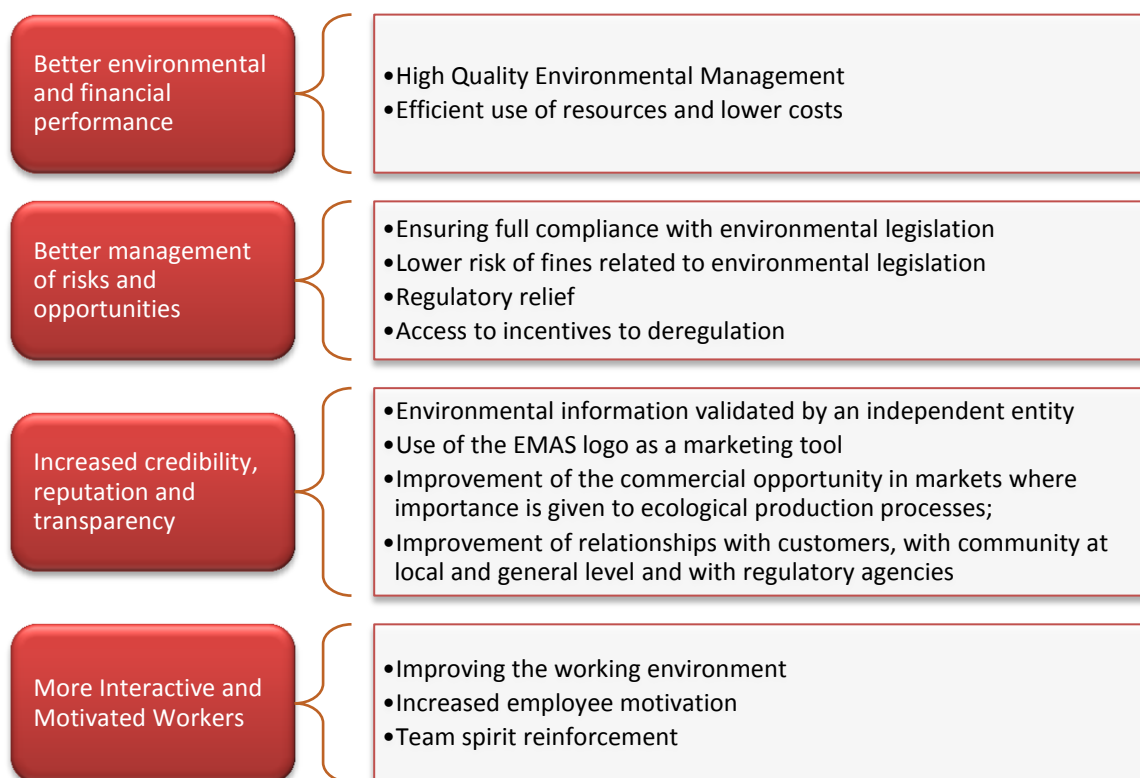


Figure 14 – Advantages of EMAS (APA, 2017)

The main advantages of EMAS can be seen in figure 14. Organizations wishing to join the Community Eco-Management and Audit Scheme (EMAS) must apply for registration with the Portuguese Environmental Agency (PEA/APA), as a Competent Body.

Prior to the application for registration with EMAS, organizations must have implemented an environmental management system in accordance with Regulation

(EC) Nº 1221/2009 of 25 November and must be in possession of an environmental statement validated by an accredited environmental verifier for the activity sector(s) of the organizations (See information on accredited environmental verifiers on the page of the Portuguese Institute of Accreditation, IP - IPAC). (APA, 2017)

2.11.2.4 Cleaner Production – Business opportunities

Cleaner production is a technical, economic and environmental strategy integrated with processes and products, to increase the efficiency in the use of raw materials, water and energy, by minimizing or recycling residues and reducing pollutant emissions. This strategy considers the environmental variable at all levels of the company, ranging from the purchase of raw materials, product engineering, design, after-sales, and it relates environmental issues to economic advantages for the company. The implementation of this strategy brings several benefits, such as (Sustentabilidade, 2014):

- Waste disposal;
- Minimization of raw materials and other inputs with an impact on the environment;
- Waste and emission reduction or elimination;
- Reduction in waste management costs;
- Reduction of expenses with fines and other penalties;
- Increased energy efficiency;
- Increased productivity;
- Improvement in health and safety at work;
- Development of environmentally adequate products;
- Strengthening the company image;
- Employee awareness.

2.11.2.4.1 Identification of the environmental Aspect and Impact

For the environmental management system, the identification of the environmental aspects associated with the activities, products or services of an organization are of

extreme importance. An organization should reflect on all environmental aspects associated with its activity, products or services (table 5).

Table 5 – Main outputs of the Printing Industry (APIGRAF, 2015)

Environmental aspect	Environmental impact
Within the EMS, such as any element of the organization's activities, products or services that may interact with the environment	Any adverse or beneficial change in the environment, resulting wholly or partially from the activities, products or services of the organization

The fact that there is a great diversity of processes, technology and final products in the printing industry makes it difficult to associate the environmental problems that are connected with it, because it is a sector that is increasingly covered with a very strict legal framework, which imposes on companies a set of quite significant requirements. Thus, various aspects and environmental impacts associated with the activity of printing industry can be identified, as seen in the table 6.

Table 6 – Environmental Aspects associated with Printing Industry (APA A. P., 2009)

Environmental aspect	Short description
Water consumption	Although printing industry does not present itself as a major consumer of water, there are processes that can generate representative consumptions, such as the preparation of pre-press baths and cleaning operations.
Energy consumption	Most equipment consumes energy. The press produces heat that is wasted afterwards.
Production of liquid effluents	In pre-press the production of washing water contaminated with agents from the photographic reproduction and the revelation of the plates takes place. In offset printing the removal of ink from the cylinders with wetting liquid can lead to the contamination of waste water with ink, solvents and cleaning agents. In screen printing, waste water can become contaminated with ink pigments, traces of diazo copies, solvents and cleaning agents when the screen is cleaned and coating removed.
Waste Production	Packaging waste resulting from printing material is produced in storage. In pre-printing stage there is the production of film waste and photo paper, printing plates, developers and fasteners, as well as cleaning cloths contaminated with solvents. Associated with the rotogravure process, sludge is also produced, which results from the treatment of galvanizing effluents containing chromium and copper. From the printing stage essentially occur residues of ink contained in drums and cans, cleaning cloths contaminated with solvents and residues from the treatment of effluents.

Noise	It comes essentially from the printing process, namely from the functioning of printing machines and their presses. In the finishing phase the machinery used for improvements produces noise.
Atmospheric emissions	In the pre-press phase the galvanisations associated with the production of rotogravure plates with chromium produce toxic mist. In screen printing the solvents can evaporate as the fabric dries. Printing causes gaseous emissions resulting from the evaporation of solvents, which are present in inks, used in the cleaning of presses and cylinders and in cleaning waters, during the printing and drying process. At the finishing stage, cleaning machines with cleaning agents containing solvents can produce gas emissions.
Soil contamination	In addition to paper, graphics stock raw materials such as solvents, flammable liquids, hazardous substances and inks. Spills or incorrect handling of these products may result in soil contamination. In the pre-press phase incorrect packaging or spill of photo printing chemicals and inks may contaminate the soil. In the printing phase, spill or incorrect handling of ink may cause soil contamination.

Table 7 – Main environmental aspects by process (APA A. P., 2009)

Unit/ Process	Environmental aspect					
	Waste	Atmospheric Emissions	Waste waters	Energy Consumption	Soil contamination	Noise
Storage	●				●	
Photo Reproduction	●		●		●	
Production of printing plates						
Offset	●		●			
Typographic	●		●			
Rotogravure	●	●	●		●	
Serigraphy	●	●	●			
Printing						
Offset	●	●	●	●	●	●
Typographic	●	●		●	●	●
Rotogravure	●	●		●	●	●
	●	●	●	●	●	●
Finishing						
Cut	●	●				●
Folding		●				●
Collage	●	●				●
Binding		●				●
Brochure		●				●
Packing	●	●				●

After identifying the environmental impacts, a cause-effect relationship must be established, in which the causes correspond to the aspects and the effects correspond to the impacts. It should be noted that not all environmental impacts are negative, and positive impacts can be registered, resulting from a given activity, product or service of the organization. Table 8 presents some examples of environmental aspects associated with products, activities and services of the printing industry. (APA A. P., 2009).

Table 8 – Environmental aspects associated with products (APA A. P., 2009)

Activity	Environmental Aspect	Potential Impact
Pre Press	Production of waste ink cartridges and toners	Soil and water contamination
	Paper consumption	Depletion of natural resources
	Sheet metal consumption	Depletion of natural resources
	Gum consumption	Depletion of natural resources
	Production of film waste	Occupation and soil contamination
	Production of waste paper and paperboard	Occupation and soil contamination
	Production of waste from sheet development process (fixative and developing baths)	Occupation and soil contamination; water contamination
	Emission of volatile organic compounds (VOCs)	Ozone layer depletion
Design and development	Production of waste ink cartridges and toners	Occupation and Soil and water contamination
	Paper consumption	Depletion of natural resources
	Production of waste paper and paperboard	Occupation and soil contamination
	Using CD`s	Occupation and soil contamination
Press	Paper consumption	Depletion of natural resources
	Solvent consumption	Depletion of natural resources
	Inks consumption	Depletion of natural resources
	Production of waste from aluminium sheets	Occupation and soil contamination
	Production of waste paper and paperboard	Occupation and soil contamination
	Production of waste inks and varnish sludge	Occupation and soil and water contamination
	Production of packaging waste - ink cans	Occupation and soil contamination
	Production of waste washing liquids	Occupation and soil contamination
	Contaminated rags	Occupation and soil and contamination
	Noise emission to the exterior	Discomfort
	Production of noise from maintenance (cauches)	Occupation and soil and water contamination
	Odours	Discomfort
	Consumption of Isopropyl Alcohol	Depletion of natural resources
	VOC emissions	Air pollution

Finishing	Consumption of varnishes	Depletion of natural resources
	Staple consumption	Depletion of natural resources
	Glue Consumption	Depletion of natural resources
	Wire consumption	Depletion of natural resources
	Paper consumption	Depletion of natural resources
	Odours	Discomfort
	Noise	Discomfort
Packaging	Waste wood	Occupation and soil water contamination
	Waste plastic	Occupation and soil contamination
	Glue Consumption	Depletion of natural resources

2.11.2.4.2 Eco- efficiency Vs. Cleaner production

Although these two concepts are close enough, the difference lies in the fact that eco-efficiency is related to economic efficiency issues that have environmental benefits, while cleaner production concerns environmental efficiency issues that have economic benefits. Among cleaner production techniques there is pollution prevention, which can be broadly defined as the set of practices, processes and technologies that prevent or minimize the generation of waste and pollutants in the generating source. The company's eco-efficiency analysis uses life-cycle assessment methodology according to the ISO 14000 series of standards and it is especially useful in the comparison of similar products, aiming the creation of subsidies for decision-making at different organization levels. The analysis of a company's eco-efficiency covers the following steps (Sustentabilidade, 2014) (UNEP, 2001):

- **Definition of the project scope:** processes or products that will be audited and alternatives that meet the needs;
- **Determination of the environmental impact of alternatives:** raw material consumption, energy, gas emissions, toxicity, potential risk, etc.;
- **Determination of the costs of each alternative:** production, investments, application and final disposal;
- **Presentation of the result:** search for the product or process with low cost and low environmental impact.

DEVELOPMENT

3.1 Used methodology

3.2 Survey conception

3.3 Search for collaborating Companies and Entities

3.4 Data collection conception

3.4.1 Specific Information About Companies

3.4.2 Information about the Company Officials

3.4.3 Sectors in the company

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3.4.5 Sustainability

3.4.6 Statistical test

3.5 Critical analysis

3 DEVELOPMENT

3.1 Used Methodology

Scientific work can be characterized by its nature, objectives, approach and technical procedures. As such, the used methodology consisted, first, in establishing the objectives of what was going to be studied. The next step was to consult bibliography. After that a conversation with an entrepreneur in the printing industry took place. This conversation led to the elaboration of an enquiry. After the enquiry was created, it was tested by the above-mentioned entrepreneur. After testing it, adjustments were made and there were established the requirements for the desired results. Then the survey was approved by the entrepreneur, a consultation was made to the association APIGRAF to collect the companies' data and, at the same time, a visit was made to the graphic industry Marsil.

The next step was the selection of the informatics platform needed to proceed with the survey. After a previous analysis, the SurveyMonkey[®] platform was selected due to reasons such as: easy of use, attractive look and allow its use free of charge. Subsequently, a learning process on how to work with SurveyMonkey[®] was needed. The next step was to place the enquiry in this application.

Besides sending the enquiry to various national companies using SurveyMonkey[®], telephone and e-mail contact was also made to the same companies, in order to ensure the answers. Replies were collected, grouped in order to achieve the necessary objectives and conclusions were drawn. The last stage was the Dissertation writing.

As technical procedure, bibliographical and documented research was used. The main objective was to identify, know and follow the development of the research according to a certain line of knowledge, in addition to providing perspectives of future work.

From this, the study was carried out on scientific articles, books, master's and doctoral theses, websites of public agencies in Portugal, Portuguese decree-laws, magazines and other sources related to the graphic arts and environmental industry.

The classification of this piece of work followed principles based on (Kipphan, 2001), in order to obtain a better temporal and logical understanding. Data processing also involves a statistical analysis, which intends to obtain significant and sufficient answers for a possible improvement in the printing industry sector.

Our first step was to present the survey conception and the data collection procedure. Then the characterization of companies inquired is carried out, through descriptive analysis techniques, as frequency tables and graphs. Then other statistical techniques are used to reach the defined objectives.

3.2 Survey conception

In order to meet the main goals of this study, a questionnaire was carried out with 37 questions, specifically concerning the environment, safety, environmental management, companies sustainable thinking, which, among others, were considered relevant to the problem. Some questions were asked in order to cross the information and thus verify the coherence in the answers. As already mentioned, SurveyMonkey® was used since it has pre-defined questionnaire models, practical with the necessary tools to send and receive data.

Once the questionnaire was completed, it was sent to companies by e-mail. The questions were made with the purpose of contributing in the best way to achieve the best knowledge about the current mind-set status of the Printing Industry regarding Sustainability. As such, Table 9 shows the different groups of questions approved, according to the study theme.

With Group 1, it was intended to characterize the company according with their main activity, their size, through the number of employees and business volume, their location, business society type, leading market and Age. In Group 2 questions are particularly focused on the director of the company and the responsible person for the purchases of raw materials, highlighting his age and schooling. Group 3 is directed towards the company's existing environmental certifications. As for Group 4, it is intended to know what types of products are produced, as well as the state of equipment. Group 5 assemblies' questions related to sustainability, in order to evaluate ideas about the environment and sustainability in the company.

Table 9 – Groups and Questionnaire Variables

Groups	Questions	Variables
Group 1 - Information business activity	Q1, Q2, Q3, Q4, Q7, Q8, Q32, Q35, Q36	Main activity, Location, Business Society, Company Age, Number of employees and business volume (Company size) and Market.
Group 2 - Information about the management of the company	Q5, Q6, Q9, Q10, Q11, Q12, Q13, , Q37	Company Director Age and Formation, Responsible for Purchasing, Age and formation of the Responsible for Purchasing, Frequencies of training, and nationality of management.
Group 3 – Certifications	Q28	Environmental certifications
Group 4 - Types of products and equipment	Q14, Q15, Q16, Q17, Q18, Q19, Q20, Q33, Q34	Criterion of selection of supplier and materials, Kind of products often, Equipment used in production, Format, Ink, New equipment investments, Ecological products and equipment
Group 5 - Sustainability	Q21, Q22, Q23, Q24, Q25, Q26, Q27, Q29, Q30, Q31	Percentage of alcohol used, Plates treatment, Offset fabrics, Catchment basin, Waste, General concern with environment and employees health and safety, Sustainable thinking, pre-dominant factor

3.3 Search for collaborating Companies and Entities

As already mentioned in the methodology, the list of companies of the printing industry was obtained through APIGRAF, with 477 associated companies. However, due to the difficulty in obtaining answers from companies, either by e-mail or by telephone, the number of answers was 103 companies (22%). From these 103 responses obtained, only 60 surveys (58%) were complete, which originated the sample for this this study.

3.4 Data collection conception

With the help of SurveyMonkey[®], the questionnaire was created and the chosen method was to send the same by e-mail. In order to obtain as many responses as possible, there was a constant telephone monitoring with the organizations, so that they could respond to the questionnaire as soon as possible. They were always told that the collected information would be strictly confidential, since the only intention of the questionnaire was to obtain sufficient data for a statistical study. The survey was conducted between January 2017 and May 2017. When the data were collected, they were placed in tables and graphs for a better illustration and representation of the results. The variables chosen through the questionnaire applied in the industries were organized in MS Excel[®] and later treated through the software *Statistical Package for the Social Sciences*, SPSS (IBM[®]), version 21.0.

According to the data distribution, the relationships between the variables under study are qualitative and independent. Thus, the chosen test was Chi-Square for independent samples. Since there are more than two groups to be related to each other, this test is most appropriate. The level of significance was 5%. For a better interpretation of the results the data are presented in graphs and tables.

3.5 Specific Information about Companies

For the accomplishment of this piece of work, some information about the companies was necessary, which was obtained through the questions of the group 1 illustrated in Table 9. All the information in group 1 enabled a better understanding of the selected companies and the knowledge of the size of each industry. Table 10 shows the main activities in the printing industry.

Table 10 – Company Specific Information

	Main activity	Frequency	%
Valid	Graphic design and pre-press	1	1.7
	Graphic Design, Pre-Press and Press	29	48.3
	Own publishing and printing	1	1.7
	Pre-press and print	21	35.0
	Printing Only	8	13.3
	Total	60	100.0

Most of the companies that answered to the survey have as main activity, Graphic Design, Pre- press and Press (48.3%). Only 1 company (1.7%) has as main activity Own publishing and printing or Graphic design and Pre-press. The second most frequent activity is Pre-press and print, which correspond to 21 companies, i.e. to 35%.

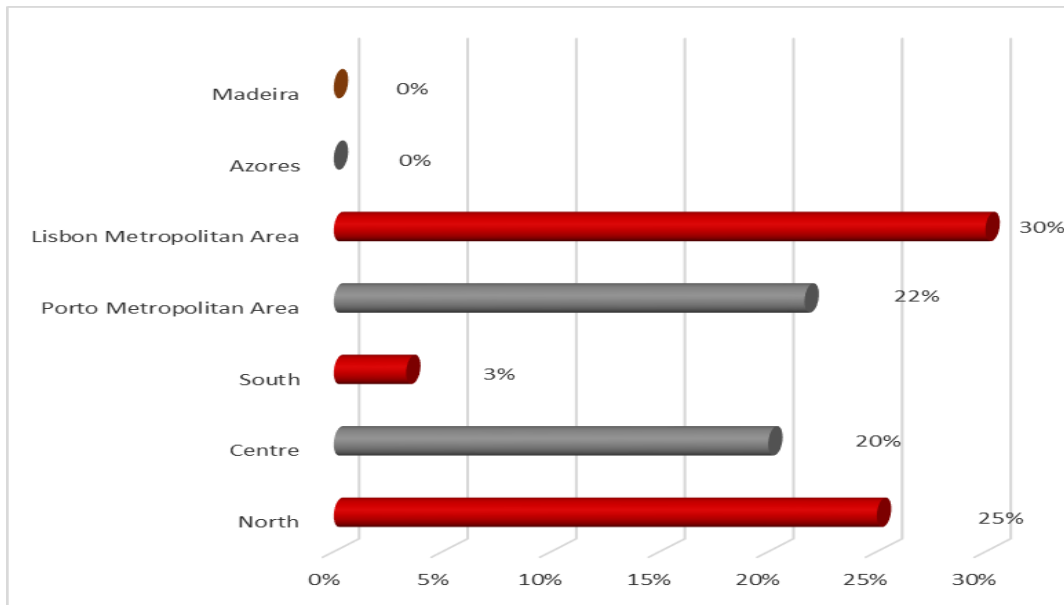


Figure 15 – Company Localization

In Figure 15 it is possible to see the region where most graphic industries are located. In total, there were analysed 60 companies distributed by some regions of Portugal. Regarding this aspect, it is possible to conclude that there is a large number of companies of Graphic Industry in Portugal, with the largest concentration in the region of Lisbon Metropolitan Area and only then in the North of Portugal, Porto Metropolitan Area, Centre and South of Portugal.

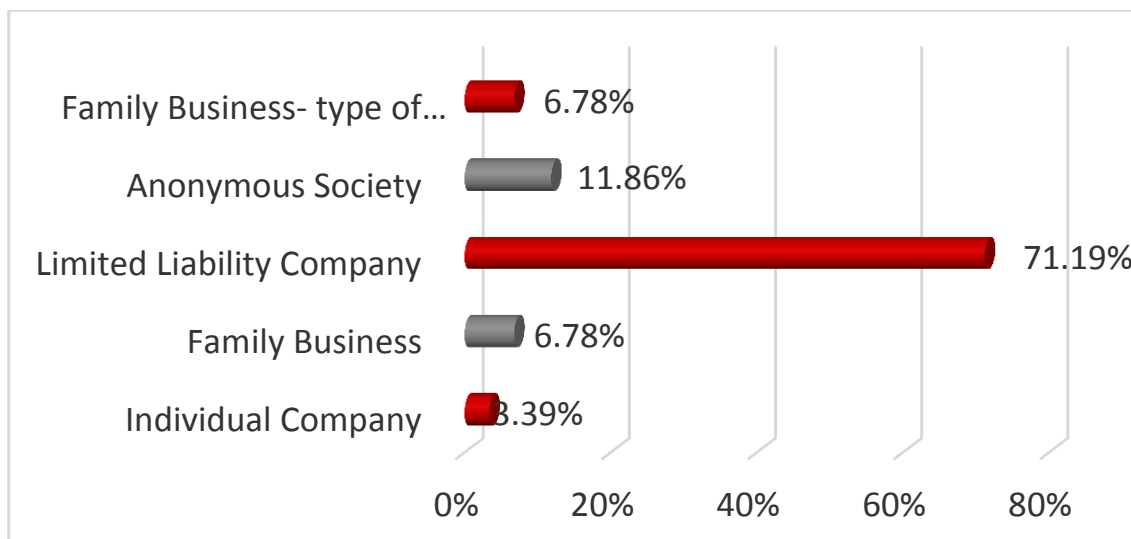


Figure 16 – Type of Company

Figure 16 shows the kind of society of the various companies in the present study. As it can be seen from this graph, most of the companies under study have a joint-stock company with a representation of 71.19% of the companies, followed by anonymous companies (11.86%). The type of society less representative in this study is the individual company (3.39%). Family businesses represent 6.78%.

Table 11 – Continuous Activity in the Printing Industry

	Company Age	Freq	%	Valid Percent	Cumulative Percent
Valid	< 1 Year	1	1.7	1.7	1.7
	1 to 6 Years	1	1.7	1.7	3.4
	6 to 15 Years	8	13.3	13.6	16.9
	16 to 25 Years	10	16.7	16.9	33.9
	> 25 Years	39	65.0	66.1	100.0
	Total	59	98.3	100.0	
Missing	99	1	1.7		
Total		60	100		

Table 11 shows that around 66.1% of the companies (39 out of 59) have been active in this sector for more than 25 years. As shown 1.7% maintain activity from 1 to 6 years, or less than 1 year. One company does not answer to this question (corresponding to the missing value).

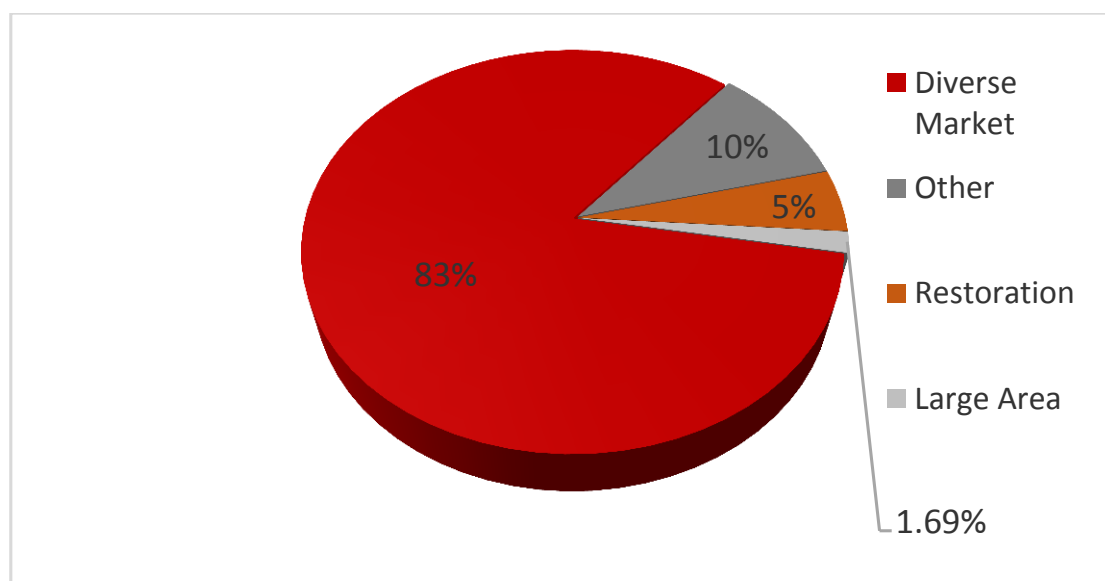


Figure 17 – Kind of Market most predominant in the company

The most significant market more significant for the majority of the companies (50 – 83.3%) is the national market, 1 company has their manufacture mostly dedicated to the foreign market and 9 of them (15%) have a mixed market. The most predominant market, according to Figure 17 is the diverse market (83%), followed by other (10%), restoration (5%) and large areas (1.69%).

3.6 Objectives and Statistical Techniques

The objectives defined in this piece of work are mainly related with sustainability and environmental concerns. In Table 12, we summarize the statistic methodologies used to reach each one of them.

Table 12 – Continuous Activity in the Printing Industry

Objective	Statistical techniques
O1 - Know how printing companies are faced with the environmental concerns	Descriptive statistics
O2 - Investigate the mind-set of the main companies' managers regarding environmental concerns	Descriptive statistics ANOVA test Spearman correlation test
O3 - Understand the linkage between better managing training and the ability of the company to adapt itself to the new environmental paradigms	T-tests
O4 - Realize the relationship between the companies' dimension and the sustainability policies	ANOVA Qui-square test
O5 - Comprehend how the purchasers and costs influence the raw materials selection in the printing process	Descriptive statistics
O6 - Understand how the technologies and products used in this kind of industry can affect the sustainability policies of the companies	ANOVA Descriptive statistics

O7 - Realize the global status of the printing industry in terms of sustainability Descriptive statistics

3.7 Sustainability - How Printing Companies are faced with the environmental concerns

In order to answer to the mentioned objectives is important to measure Companies Environmental Concerns. These are considered in Table 9 as Group 5 – Sustainability and are illustrated in Table 13. Then we defined a Sustainability Index, using the questions bellow. The question Q26, considered in group 5, was not used in the Index because it consists in a company perception about its concern with environment, which does not correspond to a real concern. Then a descriptive analysis is done to this Index, in order to answer to the objective O1, and then we calculate a Spearman correlation between the index and the perception of the company about its concern with environment.

Table 13 – Variables used to calculate the Sustainability Index

Question	Answers	Score
21 What is the percentage of alcohol used in the mixture?	0 -3%	1
	4 - 6%	0
	> 7%	0
22 How do you usually deal with the plate resulting from Offset jobs?	Metal scrap	1
	Pick Up by Certified Company for recycling	2
	Miscellaneous Scrap	0
	Other	0
23 How do you usually deal with Offset fabrics?	Pick Up by Certified Company	2
	Common Trash	0
	Selective Waste	1
24 Do you have a catchment basin in the cleaning areas?	Other	0
	Yes, in whole or in part	1
	No not at all	0
25 What is the destiny of the waste from the catchment basin?	Certified Pick Up	1
	Other	0
27 How does the company demonstrate its care with the environment?	Careful selection of the products you use	1
	Selective Pick Up of some effluent	1
	Selective Pick up of all effluents	1
	Pick Up of all Solid Residues	1
	Pick up of some solid waste	1
29 What concerns does the company usually have in selecting the type of ink to be purchased? (Indicate the answer that best fits the reality of the company).	The effects of the ink on the health of employees and the customer are taken into account	1
	In addition to price and quality, the toxicity of ink constituents is analysed	1
	Best price / quality ratio	0
	Ink toxicity is placed ahead of any other selection parameter.	2

		The fastness and drying method are the main selection parameters	0
		Collaborator responsible for monitoring HSS situations	1
		External company responsible for monitoring HSS situations	1
		Periodic training of the company's middle management	1
		Periodic training to all employees	1
		Continuously connected air renewal in the company	1
30	What are the concerns of the company in terms of health of its employees and hygiene, safety and healthy work posts (check all that are in accordance with the general practices of the company)	There is no forced renewal of air in the company	-1
		Employees have all the necessary Individual Protection Elements (PPE) and are encouraged to use them	1
		Employees have the necessary PPE, but are not encouraged to use it	-1
		There are no PPE	-1
		The collaborators are warned of all the dangers inherent in their professional activity	1
31	What is the company's concern about the quality of air in its facilities?	There is no air quality monitoring on a regular basis	0
		There is forced ventilation in areas where more toxic products are used	2
		There is only natural ventilation in areas where more toxic products are used	1

In Table 13 we present the questions considered, the answers and the score given to each answer.

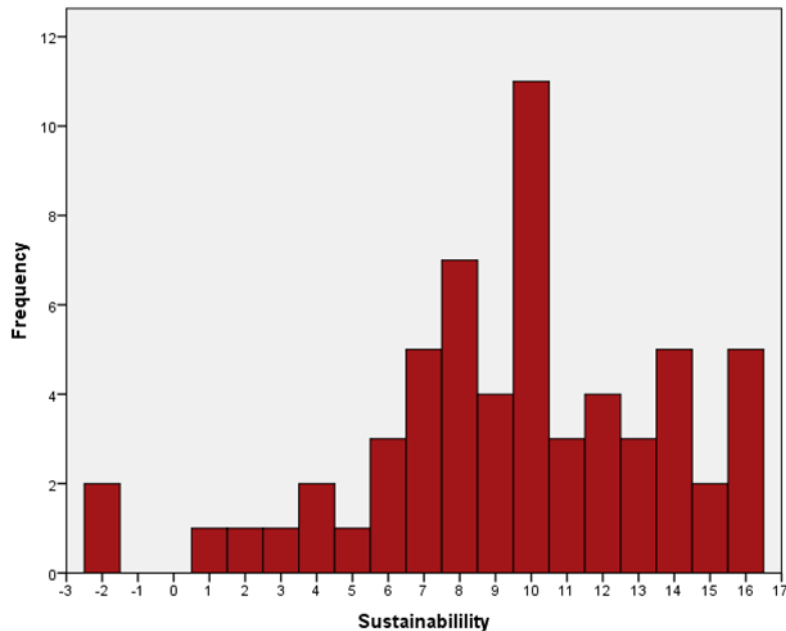


Figure 18 - Histogram of Sustainability Index

The distribution of values is illustrated in the histogram of the Figure 18. As it can be seen the minimum value of Sustainability in the surveyed companies is a negative one

(-2) which reveals that these companies show a complete lack of concerns in this area. The maximum value of Sustainability Index is 16.

The mean of the Sustainability Index is 9.5 (with standard deviation around 4.2) and the median 10, which means that 50% of the companies have a Sustainability Index greater than 10 and 50% of the companies have a Sustainability Index lower than 10. The most frequent index value is 10.

Considering the Kolmogorov-Smirnov test of normality, for the new variable Sustainability Index, which has a p-value approximately 0.2, we can consider their normality for a 5% significance level. Then we can use parametric tests (as the ANOVA and T-tests) in order to answer to the objectives.

We can also analyse if the Sustainability Index calculated is correlated with the answers to the question Q26, which consists in a company perception about its concern with environment. The variable resulting from this question has the distribution in the Figure 20.

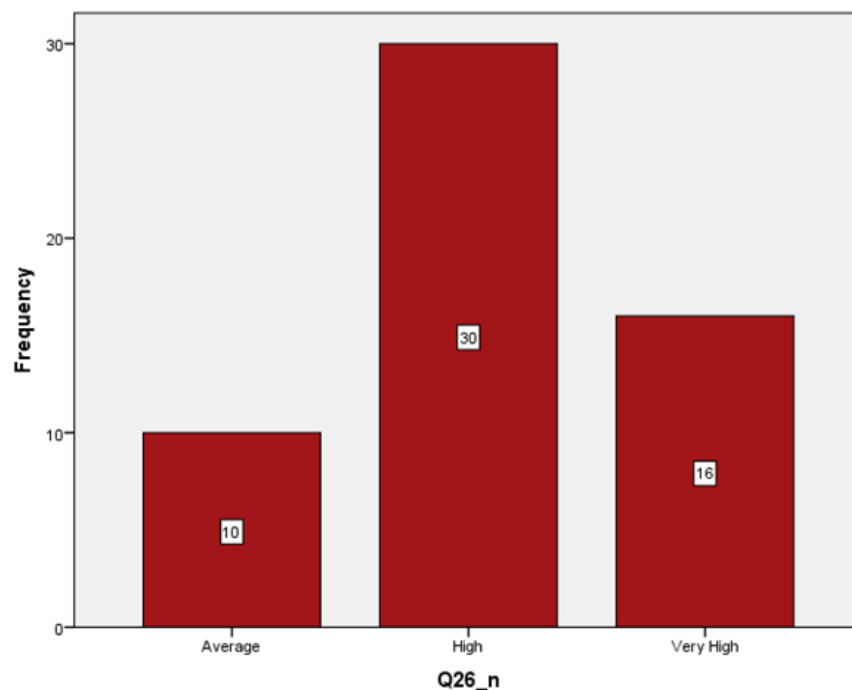


Figure 19 - Histogram of the company perception about its concern with environment

We can see in Figure 19 that the companies have in majority a high perception about their own concern with environment (30 companies – 50%) or very high (16 companies).

This variable is ordinal and then to study their correlation with the Sustainability Index we must use the Spearman correlation test, with the hypothesis:

H_0 : Sustainability Index is not correlated with the company perception about its concern with environment;

Vs

H_1 : Sustainability Index is correlated with the company perception about its concern with environment;

The p-value for this Spearman correlation test is approximately $0.576 > 0.05$, then the null hypothesis is not rejected, having statistical evidence to consider that Sustainability Index is not correlated with the company perception about its concern with environment. In fact, if we cross the information of these two variables we can see that we have companies with high and very high company perception about its concern with environment with small Sustainability Index, comparing with the other companies. Then we can conclude that the companies' environmental concerns is not real, because their perception is not according to the company practices.

3.8 Mind-set of the main companies' managers regarding environmental concerns

The purpose here is to investigate the mind-set of the main companies' managers regarding environmental concerns.

For the study concerning with the objective O2, it is relevant to analyse the data related to the Director of the Company, as well as the person responsible for the purchasing sector. The information regarding schooling and age allows a better understanding about the specific knowledge of each one. In Figure 19 we can observe the company managers' schooling.

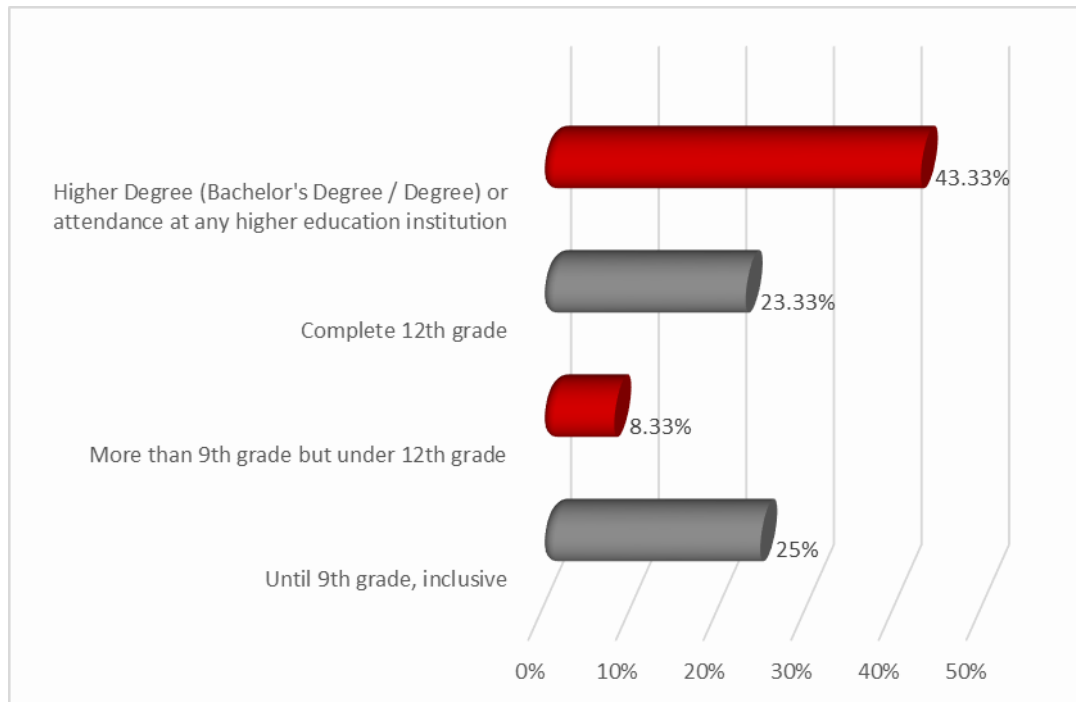


Figure 20 - CEO education

From the graph of figure 19, it can be seen that 43.33% of the general directors have higher education, and 8.33% are over 9th grade but under 12th grade.

It can be concluded that in the companies under study, the person who makes the purchases is the director of the company (64.41%), who is over 40 years. We can also conclude that most of them do not have a higher education degree, only 12th grade.

In order to investigate the mind-set of the main companies' managers regarding environmental concerns (O2), we can also consider the questions Q5, Q6, Q10 and Q11, concerning age and formation of both the Company Director and the Purchasing Manager.

We consider ANOVA tests, with null hypothesis for the equality of means of the Sustainability Index, in different groups defined by these variables.

For example, having in account the age of the Company Director we have:

H_0 : The mean of the Sustainability Index does not depend on the age range of the Company Director, or equivalently:

$$H_0: \mu_{<30 \text{ Years}} = \mu_{\text{Between 30 and 40 Years}} = \mu_{>40 \text{ Years}}$$

Vs

H_1 : At least one of the means differs from the others.

The p-value for this ANOVA test is approximately $0,9 > 0,05$, then the null hypothesis is not rejected, having no statistical evidence to consider that the age of the Company Director does not affect the Sustainability Index of the companies.

Doing an analogous procedure, we concluded that per age and formation of the Company Director and of the Purchasing Manager we do not reject the null hypothesis of equality of means, i.e., we do not identify significance differences in the mean of the Sustainability index, for the different groups defined by these variables.

Then we can conclude that age and training of the Company Director and of the Purchasing Manager are not related to the mind-set of the main companies' managers regarding environmental concerns.

Other interesting topic concerning with mind-set of the main companies' managers is the certification of companies. There are several types of certifications that printing companies can have. In order not to overcome the framework of the subject, only two types of certification will be considered: ISO 14000, ISO9001 and others (EMAS).

Table 14 – Certification of the Printing Industry companies

		Frequency	Percent	Valid Percent
Valid	Other	9	14.5	50.0
	ISO 9001	9	14.5	50.0
	Total	18	29.0	100.0
Missing	3	42	67.7	
	System	2	3.2	
	Total	44	71.0	
Total		62	100.0	

Table 14 shows on how the printing companies in Portugal are positioned in terms of Certifications. Table 14 shows that 50% of the companies under study has ISO9001 and none has ISO14000. It is possible to conclude that 50% has another type of normative reference such as Portuguese System of Sustainable Forest Certification and Forest Stewardship Council. The fact that some companies (18 companies, i.e. 29%) have this type of certificate demonstrates that they feel the responsibility of managing in a sustainable way, thus verifying the traceability of certified forest-based materials and products along the production chain to the final consumer. In other way 42 companies (67.7%) do not have this feel of responsibility.

Through FSC® or PEFC® Certification, customers and consumers are able to identify the original products of forests managed in a responsible / sustainable way and contribute, through the market's driving capacity, to stimulate the continuous demand potential of the management of forest resources.

We can also study the relation between the calculated Sustainability Index and the existence of certification using ANOVA. The results are presented in Table 15.

Table 15 - ANOVA: Certification vs Sustainability Index

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	78.270	2	39.135	2.307	0.109
Within Groups	966.730	57	16.960		
Total	1045.000	59			

The ANOVA hypothesis are:

$H_0: \mu_{ISO\ 9001} = \mu_{Other} = \mu_{No\ certification}$ (i.e., The mean of the Sustainability Index does not depend on the certification by ISO 9001, other or no certification)

Vs

H_1 : At least one of the means differs from the others.

Once that the p-value of the test is approximately $0.109 > 0.05$, then the null hypothesis is not rejected, then there is no statistical evidence to consider differences in the Sustainability Index, for companies with ISO 9001 certification, other certification or no certification.

However, if we consider certificate or no certificate companies, using the T-Test (results in with the hypothesis:

$H_0: \mu_{Not\ certificate} = \mu_{certificate}$ (i.e., The mean of the Sustainability Index does not depend on the certification or no certification).

Vs

$$H_1: \mu_{\text{Not certificate}} \neq \mu_{\text{certificate}}$$

The results presented in Table 16 show a p-value approximately $0.019 < 0.05$, then the null hypothesis is rejected, and then there are statistical evidence to consider differences in the Sustainability Index, for certified companies and no certified. Besides that, the 95% Confidence Interval of the Difference is $I = [-4.49780; -0.42284]$, indicating that the not certified companies had less mean values for the Sustainability Index than certified companies.

Table 16– T-test: Certification vs Sustainability Index

t-test for Equality of Means							
T – Test	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
Equality of means							
Equal variances not assumed	-2.433	44.241	0.019	-2.46032	1.01113	-4.49780	-0.42284

These tests demonstrate that the certificate companies have more feel of the responsibility of managing in a sustainable way, comparing with the non-certificate companies.

3.9 Managing training and new environmental paradigms

To understand the linkage between better managing training and the ability of the company to adapt itself to the new environmental paradigms (O3), we can consider the questions Q12 and Q13, about the attending training of the respondent to the survey.

Despite the frequency of training in the last year, only 22.58% was related to the environment. In the first place, there are other types of training such as stock management, financial, conflict management, among others.

Besides that, using T-tests, with hypothesis:

H_0 : The mean of the Sustainability Index does not depend on training.

Vs

H_1 : The mean of the Sustainability Index depends on training

we do not find significative differences between the Sustainability Index for companies where the respondent affirms to attend any training, in the last year or not (Q12).

In addition if we consider the particular answers about the subject of the training (Q13) we obtain the p-values in T-tests in Table 17.

Table 17–T-tests results for training subjects

<i>Training Subject</i>	<i>p-value</i>
Environment	0.039
Stock / Financial Management	0.569
Search and Selection of Suppliers	0.626
Compliance with regulations	0.048
Other	0.784

Having into account the information in Table 17 (in bold) we can conclude that only training about Environment and Compliance with regulations have as consequence a significative effect on the mean of the Sustainability Index, for a significance level of 5%.

3.10 Companies' dimension and the sustainability policies

In order to study if sustainability policies are different for Companies of different dimensions (O4) we used ANOVA. The results are presented both in Table 15 and Table 18 .

Table 18 - ANOVA: Size vs Sustainability Index

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	9,103	2	4,552	0,250	0,779
Within Groups	1035,897	57	18,174		

Total	1045,000	59
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The ANOVA hypothesis are:

$H_0: \mu_{Micro} = \mu_{Average} = \mu_{Small}$ (i.e. The mean of the Sustainability Index does not depend on the company's size)

Vs

H_1 : At least one of the means differs from the others.

Once that the p-value of the test is approximately $0.779 > 0.05$, then the null hypothesis is not rejected, then there is no statistical evidence to consider differences in the Sustainability Index for different size companies.

Then we can consider fulfilled the objective O4, because it was possible to verify that there is not a relationship between the companies' dimension and the sustainability policies.

3.11 Purchasers and costs and raw materials selection

In order to understand how the purchasers and costs influence the raw materials selection in the printing process (O5) we can analyse the answers to the questions Q9, Q14 and Q15.

Data depicted in Table 19 are related with whom usually does the purchases in companies.

Table 19 - Who usually does the purchases in companies

		Frequency	Percent	Valid Percent
Valid	Responsible for Purchasing	13	22%	22%
	Other	8	13%	14%
	General Director of the Company	38	63%	64%
	Total	59	98%	100%
Missing	4	1	2%	
Total		60	100%	

It is possible to see that in majority, the purchases are done by the General Director of the Company (64%), 22% by a Responsible for Purchasing and in 14% of the companies other people do the purchases.

At the time of buying, purchasers give more importance almost entirely to the price (98.3%) and a small part to the Ecological Products (1.7%).

However, the second factor in this selection, as illustrated in Figure 21, is Ecological Products.

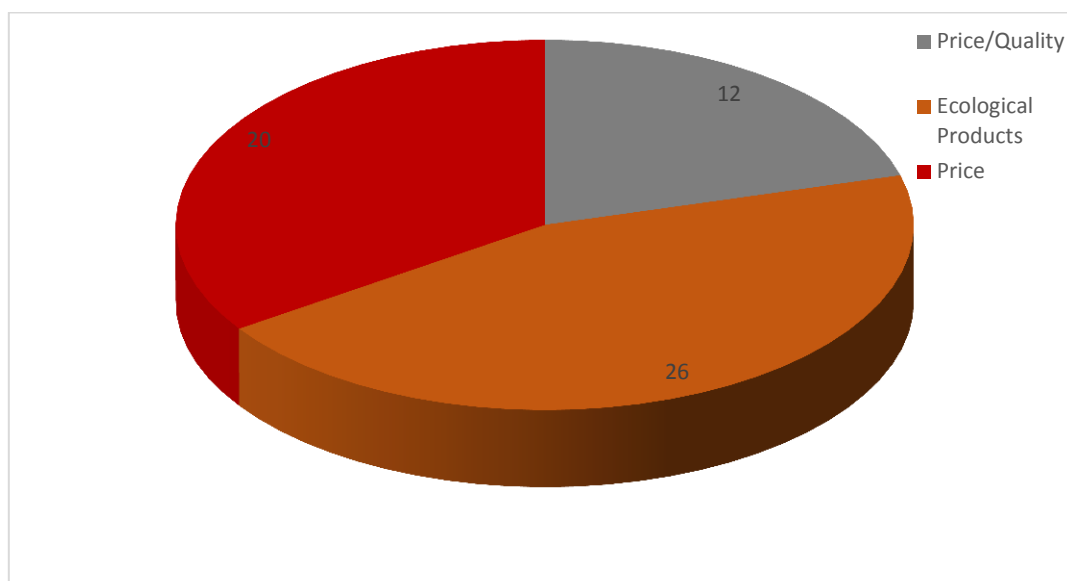


Figure 21 - Second factor in selection of materials

If we cross the information about these two questions, who purchases and the factors that influence purchase, we obtain the results in Table 20.

Table 20 - Cross information about purchase and factors

		Secondary Factor in the selection of materials			Total
		Price / Quality	Ecological Products	Price	
Who usually makes Purchases	Responsible for Purchasing	0	5	7	12
	Other	0	5	3	8
	General Director of the Company	11	16	10	37
Total		11	26	20	57

Results in Table 19 suggest an association between both purchasers and factors. It seems that General Directors of the Companies are most concerned with price. This idea is reinforced if we consider the Qui-square test, with null hypothesis for the independence between the variables, i.e. the factors influencing the purchases are independent of the position of the Responsible for Purchasing in companies. The null hypothesis is rejected for a 6% significance level indicating an association. The association measures, $\Phi = 0,399$ and Cramer's $V = 0,282$, indicates a moderate association, but existent for the same significance level.

Thus, the purchasers and costs are very important in raw materials selection in the printing process.

3.12 Technologies and products and sustainability policies

In order to achieve a good image in the market, the graphic industry tends to adapt its processes, so that they fit into the correct environmental policies and thus prove the existence of concern and responsibility with the environment.

To check whether companies have sustainable thinking they were questioned if they recently did investments, or were considering investing in new equipment. Figure 22 shows the results obtained regarding this question.

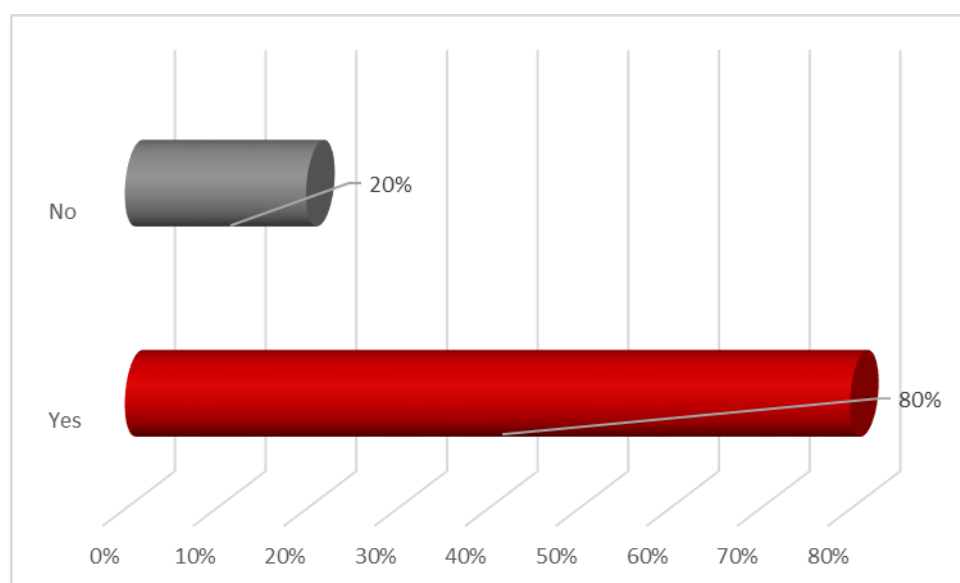


Figure 22 – Investments in equipment

As it can be seen in Figure 22, 80% of the companies have recently made investment in new equipment.

Because all stages of the graphic process produce waste that affects the environment, the study also focused itself on the type of equipment and technology that companies use regularly in the printing and finishing process. This definition prevails for all printing systems, but the focus in this piece of work was only offset printing. Figure 23 shows the equipment and technology used in the printing process.

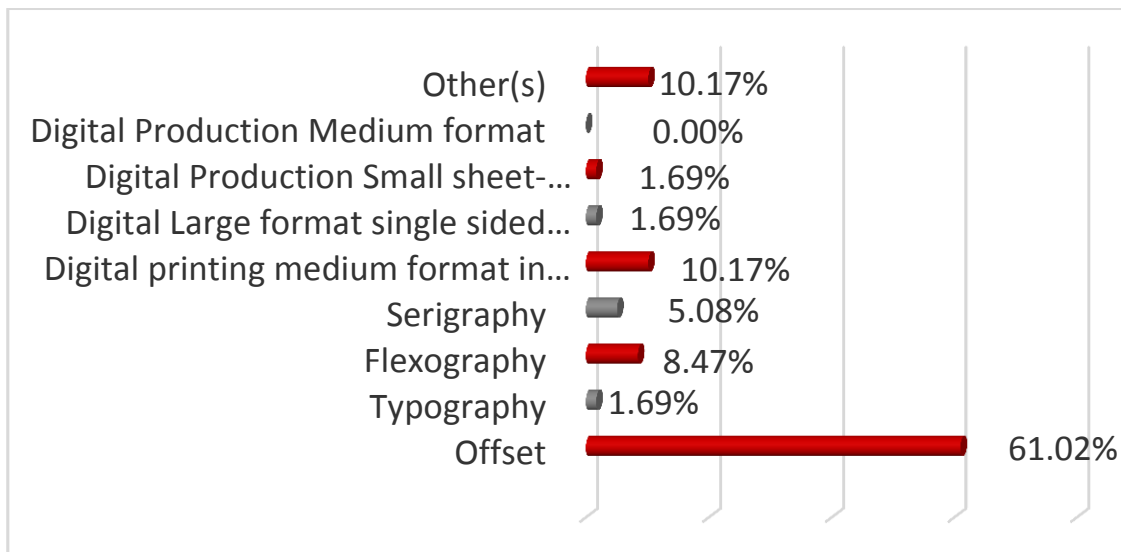


Figure 23– Equipment and technology of printing processes and finishing used

From the data provided by **Erro! A origem da referência não foi encontrada.**, it is possible to conclude that most of the companies studied use the Offset System (61.02%). The offset system uses several products that can be harmful to the environment, due to the use of several mechanisms. Because of that, the study was directed to put some straight questions about the formats they work in, the type of inks they use in this system, the percentage of alcohol, what they do with the cleaning cloths, catchment basins and with the plates used.

Figure 24 shows the main products/formats usually used by companies working in printing industry.

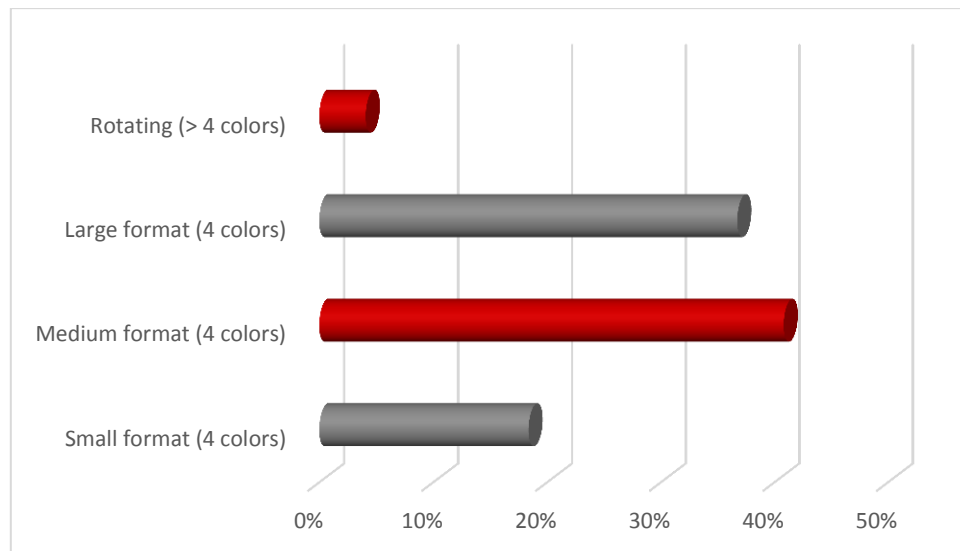


Figure 24– Formats of offset printing companies work

As it can be seen in Figure 24, most of the companies under study (40.83%) work with the medium format in offset printing. To understand how the technologies and products used in this kind of industry can affect the sustainability policies of the companies (O6) we can analyse the sustainability index for these categories. Both variables (Equipment/technology and formats) conduce to a p-values <5%, having significance evidence to reject the equality of means. It means that technologies and formats affect the sustainability index. In case of format, no significant differences of the sustainability index means were identified between large and medium format, but a difference in the sustainability index between rotative and small formats is verified.

If we consider the kind of products most often produced by the companies (Q17), equipment and technology, which are those that the company owns and uses regularly in printing and finishing processes (Q18), are obtained similar results to the previous ones. They affect the sustainability index and consequently the policies of the companies. On the other hand, that kind of ink used for offset work (Q20) was not a significant difference of the sustainability index mean. Thereby the technologies and products used in this kind of industry can affect the sustainability policies of the companies.

3.13 Global status of the printing industry in terms of sustainability

In the Printing Industry, there are several important areas for the product preparation. In spite of the importance of several areas, from raw material to quality control of the finished product, only two areas will be highlighted. These are the purchasing area and Hygiene, Health and Safety at Work, which become relevant when well used. In this section, we analysed some questions in the questionnaire in order to have a global status of the printing industry in terms of sustainability (O6).

The latter is extremely important in the printing industry, both at the environmental level and regarding the workers' health and safety. Here methodologies can be found that allow good handling in the storage of flammable materials, a good use of machines, adequate lighting in the workstation, good handling of chemicals and use of personal protective equipment. **Erro! A origem da referência não foi encontrada.** shows the concern of the companies in terms of Hygiene, Health and Safety area.

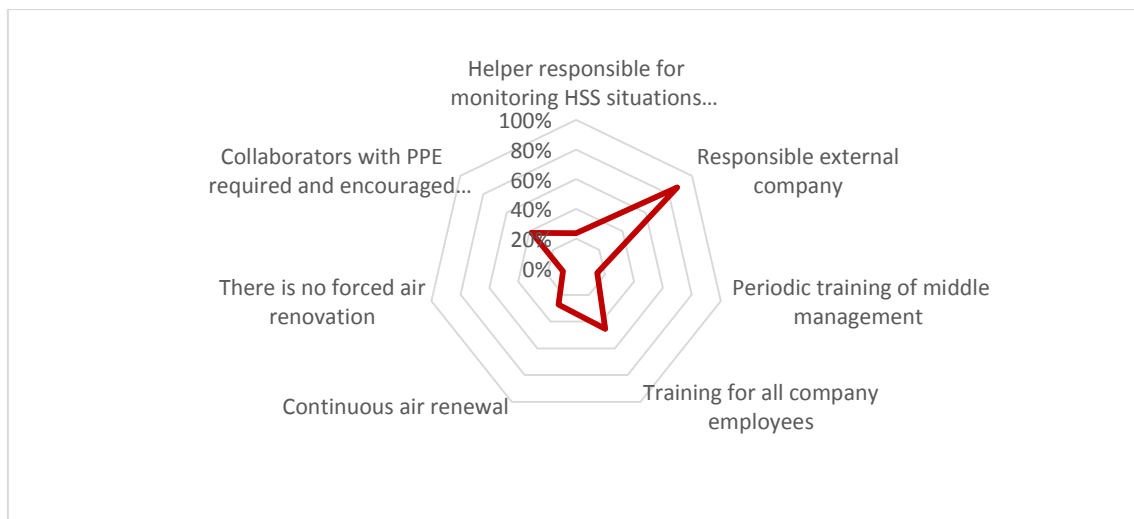


Figure 25– Concern of the companies relating Hygiene, Health and Safety at Work

As in general industry, the purchasing area plays an extremely important role in the printing industry. This is where the best suppliers, environmental and economic requirements are normally analysed. Here, it was defined as necessary to understand what companies value in the choice of supplier, main and secondary factor and the operation of the supplier selection process.

Table 1 shows the main factor that companies, when buying products, value when choosing suppliers.

Table 1 - Main factor in the choice of supplier

Factor	Frequency	%
Ecological Products	1	1.7
Quality / Price	59	98.3
Total	60	100.0

The main factor to be valued in the selection of the supplier is the quality/price ratio (98.33%).

The secondary factor is more diverse (see Figure 26), being the Ecological Products the most frequent (44.8%), followed by Price (34.5%) and Quality / Price (20.7%).



Figure 26 – Secondary factor in the choice of supplier

Figure 27 shows how companies carry out the supplier selection process.

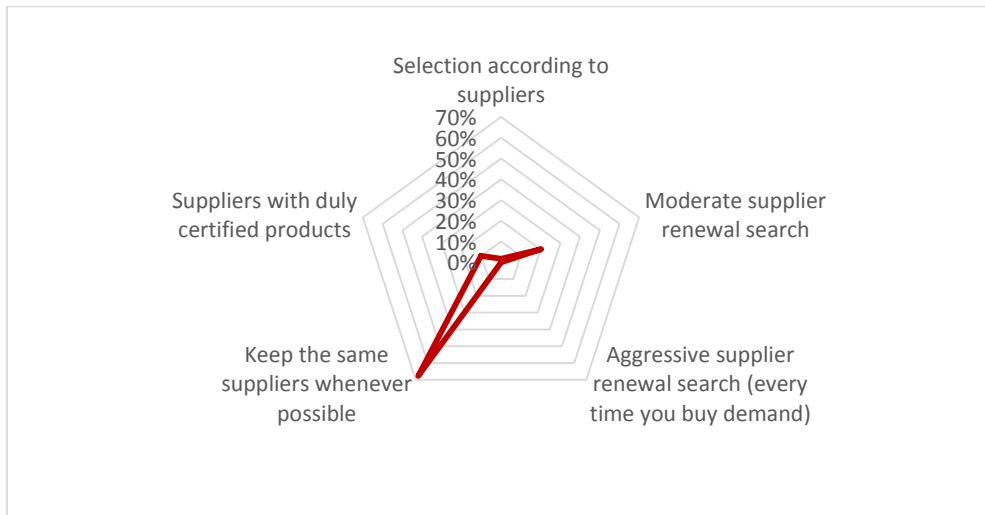


Figure 27 – Supplier selection process

As it can be seen in the graph shown in Figure 27, most companies keep the same suppliers whenever possible (67.80%). Among the companies analysed, only 1.69% make the selection based on the suppliers received proposals.

The method of drying the ink from the Offset process, as it can be observed from Figure 28, is drying by oxidation.

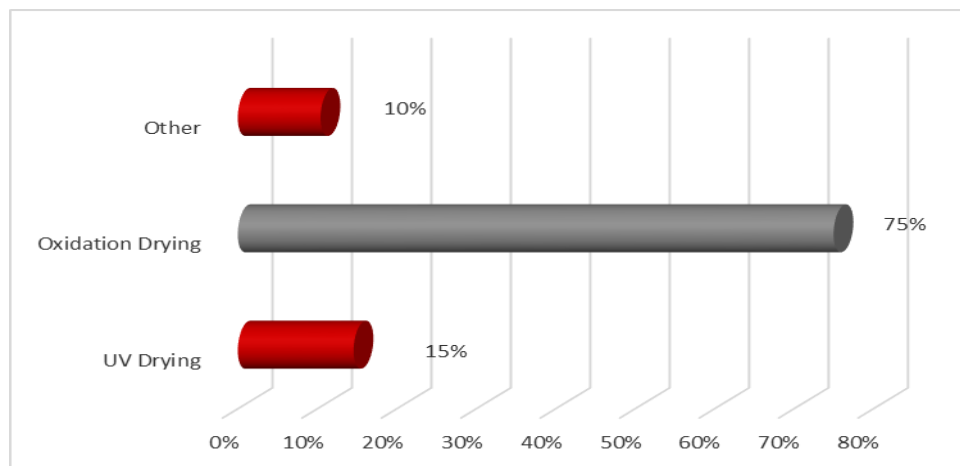


Figure 28 – Offset Printing Inks

CONCLUSIONS

4.1 CONCLUSIONS

4.2 FUTURE WORK

4 CONCLUSIONS AND FUTURE WORK PROPOSED

4.1 CONCLUSIONS

This piece of work was developed with the purpose of checking the environmental commitment that the Portuguese printing industries have in their activity.

In order to identify the main hazards, throughout the production process of Printing Industry, a detailed bibliographical research was necessary.

In Portugal there are approximately 2286 printing industries. By the Portuguese Association of Graphic Industry and Paper Transformation, it was possible create a database of companies registered in Portugal. The next step was the telephone contact to each company, with the purpose of analyzing the possibility of participating in the research. Of the companies surveyed, only 58% accepted to participate in this study.

The results of the questionnaire made it possible to directly support the study and the creation of data, so that they could be interpreted and discussed, and also be transformed into variables for the tests of necessary hypotheses that were carried out in this piece of work.

Most of the answers were from the Metropolitan Area of Lisbon with 30% of the answers, followed by the North region with 25%. From Madeira and the Azores, no response was obtained.

The variables “Sustainability Index is not correlated with the company perception about its concern with environment;” and “Sustainability Index is correlated with the company perception about its concern with environment;” intended to analyse the existence of some statistical relationship between them. In fact, if we cross the information of these two variables we can see that we have companies with high and very high company perception about its concern with environment with small Sustainability Index, comparing with the other companies. Then we can conclude that

the companies' environmental concerns are not real, because their perception is not according to the company practices.

It can be concluded that in the companies under study, the person who makes the purchases is the director of the company (64.41%), who is over 40 years. Then we can conclude that age and training of the Company Director and of the Purchasing Manager are not related to the mind-set of the main companies' managers regarding environmental concerns.

Regarding certifications, most of the companies studied are certified by ISO9001, and some by other type of benchmarks such as Portuguese System of Sustainable Forest Certification and Forest Stewardship Council. The fact that some companies (18 companies, i.e. 29%) have this type of certificate demonstrates that they feel the responsibility of managing in a sustainable way, thus verifying the traceability of certified forest-based materials and products along the production chain to the final consumer. In other way 42 companies (67.7%) do not have this feel of responsibility.

However, if we consider certificate or no certificate companies, using the T-Test (results in with the hypothesis: "The mean of the Sustainability Index does not depend on the certification or no certification;" and "The mean of the Sustainability Index depends on the certification or no certification;" These tests demonstrates that the certificate companies have more feel of the responsibility of managing in a sustainable way, comparing with the non-certificate companies.

The variables "The mean of the Sustainability Index does not depend on training;" and "The mean of the Sustainability Index depends on training;" intended to understand the linkage between better managing training and the ability of the company to adapt itself to the new environmental paradigms. we can conclude that only training about Environment and Compliance with regulations have as consequence a significative effect on the mean of the Sustainability Index.

It was possible to verify that there is not a relationship between the companies' dimension and the sustainability policies.

There are two important departments in this type of industry: Hygiene, Health and Safety at Work and Purchasing. As for environmental concern, Hygiene, Safety and Health at Work, whose methodologies allow the good handling of flammable materials, good use of machines, adequate lighting for the workplace, good handling of chemicals and use of equipments for individual safety, can contribute to a better atmosphere into the companies and a sustainable behaviour.

In the purchasing department best suppliers are chosen according to environmental and economic requirements. In this piece of work, it was defined as necessary to understand what companies value when choosing a supplier, the main and secondary factor for its choice and the procedure of the supplier selection process. Thus, the purchasers and costs are very important in raw materials selection in the printing process.

In general it can be said that the analysed companies have yet a long way ahead of them in order to improve their environmental and sustainable practices.

**BIBLIOGRAPHY AND OTHER
SOURCES OF INFORMATIONS**

5 BIBLIOGRAPHY AND OTHER SOURCES OF INFORMATIONS

5.1 Bibliography

- Ana Domingues, J. B. (2006). *Ecodesign*. Lisboa, Portugal.
- Ange, I. . (s.d.). Licenciamento Ambiental. *Como retirar o máximo proveito da legislação em vigor*. Farol do Vento.
- APA, A. P. (junho de 2009). Manual de Implementação do Emas no Setor da industria Gráfica . Amadora.
- APIGRAF. (2015). *Anuário Indústrias Gráficas E Transformadoras do Papel*. Porto: Norprint.
- Barbosa, C. (2005). *Manual Prático de Produção Gráfica*. Cascais: Principia.
- Correia, A. (2016/2017). Conceitos Introdutórios - Associação entre Variáveis. *Metodos Quantitativos - Mestrado em Gestão e Internacionalização de Empresas*. Escola Superior de Tecnologia e Gestão.
- CTP. (2016). *NP EN ISO 14000:2015*.
- Cury, A. (2006). *Organização e Métodos: uma visão holística* . Sao Paulo: Atlas.
- INETI. (2000). *Guia Técnico- Setor Industria graficas e transformadoras de papel*. Lisboa
- Kipphan, H. (2001). *Handbook of Print Media*. Germany: Heidelberg.
- Laureano, R. M. (2013). *Testes de Hipóteses Com SPSS*. Lisboa: Silabo.
- Ribeiro, A. (2004). *Desempenho Empresarial em Industrias de Artes Gráficas*. Faculdade de Engenharia da Universidade do Porto.
- Silva, M. R. (2001). *Motivações para a adopção de Estratégias Ambientais pelas Empresas - o caso da Indústria Gráfica Portuguesa*. Lisboa: FCT/UNL.
- Sustentabilidade, G. d. (2014). Guia de Sustentabilidade de materiais e serviços de impressão.
- UNEP. (2001). *Cleaner Production Sixth International High -Lever Seminar* . Montreal.

6 Web Sites

- Adhepel. (n.d.). <http://www.adhepel.com.ar/>.
- APA. (2017). <http://apambiente.wixsite.com/emas>.
- Europress. (2017, Agosto 8). <https://europress.pt/acabamento/>. Retrieved from <https://europress.pt/acabamento/>.
- Serigrafia, C. P. (2017, Agosto 8). <https://www.cps.pt/default/pt/homepage/obragraficaoriginal/tecnicas>. <https://www.cps.pt/default/pt/homepage/obragraficaoriginal/tecnicas>.
- Sustentabilidade, G. d. (2014). Guia de Sustentabilidade de materiais e serviços de impressão.

ATTACHMENTS

7.1 Printing Industry Legislation

7.1.1 Survey

7 Attachments

7.1 Printing Industry Legislation

General list of legislation applicable to the Printing Industry - Environmental Legislation

Degree	Date	Description	Description of Applicability
Law n.º 11/87	Abr-87	Basic Law of the Environment. Defines the basis of the policy of Environment	Guidance document on environmental policies "All citizens have the right to an ecologically balanced environment and the duty to defend the environment ..." "The issuance, transportation and final destination of the waste is subject to prior authorization" "The responsibility for the fate of the various types of waste is of the one who produces" For framing only, no direct requirements
Decree-Lawn.º 97/2003	Mai-03	Approves the organization of the Ministry of Cities, Spatial Planning and Environment. Repeals Decree-Laws No. 120/2000 of 120/2000, of 4 July, and 8/2002, of 9 January.	To the company knowledge. Creation of the new Ministry of Cities, Spatial Planning and Environment. The competencies of the agency, agencies, services and entities of an entrepreneurial nature are redefined according to the new XV Government policies. Establishes a new organic with regard to It establishes a new organic with regard to regional development and deconcentrated environmental policies, spatial planning, nature and biodiversity conservation, and support for local government by merging regional coordination commissions and regional environmental and regional coordination and development commissions (CCDR)
Decree-Law n.º 173/2008	Ago-2008	It lays down the legal framework for integrated pollution prevention and control, transposing into the national legal order Directive 2008/1/EC of the European Parliament and of the Council of 15 January.	
Decree-Law n.º 288/2007	Ago-2007	It grants applicants for permits or licenses for industrial installations, facilities of the National Electric System, of the National Natural Gas System and the National Petroleum System, the possibility of immediately instructing them with the required opinions.	
Decree-Law n.º 254/2007	Jul-2007	Establishes the accident prevention regime involving dangerous substances and limiting the consequences thereof. for man and the environment, transposing into the domestic legal order Directive 2003/105/EC of the European Parliament and of the Council of 16 December amending Council Directive 96/82/EC, of 9 December, on the control of major-	

		accident hazards involving dangerous substances.	
Decree-Law n.º 226/2007	Mai - 2007	It lays down the rules governing the use of water resources.	
Decree-Law n.º 9/2007	Jan-2007	Approves the General Noise Regulation and repeals the legal regime for noise pollution, approved by Decree-Law no. 292/2000, of 14 November.	Applicable to: construction, reconstruction, enlargement, alteration or conservation of buildings; construction works; operation of industrial establishments; outdoor use equipment; sound alarm systems. It defines 3 periods: daytime (7 a.m. to 8 p.m.), afternoon (20 a.m. to 23 p.m.) and night (a.m. to 7 p.m.). Defines 3 zones: mixed, sensitive and consolidated. Mixed areas shall not be exposed to external ambient noise exceeding 65 dB (A), expressed by the Lden indicator (daytime-evening-night) and exceeding 55 dB (A) expressed by the Ln indicator (night-time). exposed to external ambient noise exceeding 55 dB (A), expressed by the Lden Lden indicator (day- night-time) and greater than 45 dB (A), expressed by the Ln (night) indicator. The installation and the exercise of noisy activities remain in mixed areas, in the environs of sensitive or mixed areas or in the proximity of isolated sensitive receivers, are subject to: a) the length of the limit values fixed ; b) to the length of the discomfort criterion, considered as the difference between the LAeq indicator value of the environment noise determined during the occurrence of the particular noise of the activity or activities under evaluation and the value of the residual noise indicator LAeq. Determines that with the company stopped and working, so that there is no discomfort, its difference must be less than or equal to: Day period less than or equal to 5 dB (A), afternoon period less than or equal to 4dB (a) and Night period less than or equal to 3 dB (A).
Ordinance n.º 1057/2006	Set - 2006		Subject to the payment of fees, the application for the issuance, alteration, renewal and updating of the environmental license for installations that are outside the scope of application of Decree-Law no. 69/2003, of 10 April. It is subject to payment of the fees in the present ordinance the application of emission, change, renewal and license update outside the scope of the Decree-Law No 69/2003. The fees must be paid in the moment of presentation of the requirement by the interested person in the regulatory authority of the licensing or authorization of the installation, even though there is only licensing environmental. The non-payment of fees in the time of application determines the termination of the issuing, amending, renewing or updating the environmental license, in the general

			terms of the Administrative Procedure.
Ordinance nº 1023/2006	Set - 2006	Defines the elements that must accompany for the licensing of storage, sorting, treatment, valorization	Those who wish to obtain licensing of warehouse operations, sorting, treatment, recovery and disposal of waste should send the application for licensing that must be submitted to the licensing entity. This must include the identification of the applicant, the tax identification number and the description of the operations that he/she intends to carry out and of its geographical location accompanied by the installation project (descriptive report) and drawings.
Decree-Lawn nº 178/2006	Set - 2006	Approves the general regime of waste management, transposing to the internal legal order Directive 2006/12/EC of the European Parliament and of the Council of 5 April No 91/689/EEC of 12 from December.	<p>It applies to waste management operations, understanding any and all operations for the picking, transport, storage, sorting, treatment, recovery and disposal of waste. Waste management is an integral part of its life cycle, and it is the responsibility of the producer, except for cases of municipal waste in which the daily production does not exceed 1100 liters, in which case its management is assured by the municipalities. In case of impossibility of determination of the producer of the waste the responsibility rests with its holder. When the waste comes from outside its management it is the responsibility of its introduction in the national market. The responsibility for waste management may be transferred to a licensed operator or to an entity responsible for waste stream management systems. The waste management hierarchy should be: prevention, reuse, recycling, energy recovery, landfills.</p> <p>Waste producers should separate them from the source, giving priority to using the best available technologies with economically sustainable costs. They are subject to licensing: warehousing, sorting, treatment, recovery and disposal operations. The collection and transport of waste and the storage of waste that is carried out at the place of production for periods of less than one year are not subject to licensing. The integrated electronic registration system (SIRER) is created which aggregates information on waste produced and imported to the national territory. Producers of non-urban waste who employ at least 10 workers are subject to the SIRER; urban waste whose production does not exceed 1100 liters; hazardous waste from agricultural and forestry activities; other dangerous waste. The records of the year 2006 shall be completed by 31 May 2007. For the following years, the maps shall be completed by the end of the month of March following each year.</p>
Ordinance nº 1047/2001	Set - 2001	Approves the licensing order template economic activities covered by the Decree-Law No 194/2000 of 21 August, which approved the legal regime of and Integrated Pollution Control (IPPC).	The PCIP form is mandatory, even if it is an existing, renewed installation or environmental license updates or substantial changes to the installation. Access to the form can be done on the pages of the entities responsible for licensing, which allows its easy filling in digital format or paper.

Decree-Lawn nº 69/2000(republicado pelo DL 197/2005, de 8 de Novembro)	Mai - 2000	Approves the legal regime of impact assessment environmental, transposing to theof Directive 85/337/EEC,with the amendments introduced by DirectiveNo 97/11/EC of the Council of 3 March	In addition to the projects included in Annexes I and II, projects that, due to their special characteristics, size and nature, may be considered susceptible to an impact susceptible to the environment may be subject to AIA.
Decree-Lawn nº 194/2000	Ago 2000	It transposes into the internal legal order Directive 96/61/EC of the Council of 24 September 2001 on the prevention control and integrated pollution.	Environmental licensing includes surface treatment facilities for substances, objects or products using organic solvents, namely printing, with a consumption capacity of more than 150 kg of solvents per hour or 200 t per year. If the installation is covered by the PCIP, it must have proof of sending to the IA the identification form in which the code (s) of the activity (s) concerned should be governed. Companies must have an environmental license if they are covered by this decree, or if a change has been made if it is a new installation. In the case of an installation subject to AIA, the licensing procedure can only begin after the issuance of favorable AIA or favorable conditioning. The covered facility shall also send to the competent authority the emission monitoring results imposed on the license. They must send the response to the emissions form on time.

7.2 Survey

This survey intends to investigate the current state of the Portuguese Graphic Industry in terms of Sustainable Development. The information contained in this survey is confidential to your company will be included in the lot of companies that responded to the inquiry, but privacy will be guaranteed.

Sustainable Development Graphic Industry

1. Main activity of the company:

Graphic design

Printing Only

Pre-press and print

Graphic design and pre-press

Graphic design pre-printing and print

Edition

Own publishing and printing

2. Company Location:

North

Centre

South

Metropolitan area of Porto
Metropolitan area of Lisbon
Azores
Madeira

3. Type of Business Society:
Company in Individual Name
Family business
Limited liability company
Anonymous society

4. How long have you been working in the Printing Industry?
<1 Year
1 to 6 Years
6 to 15 Years
16 to 25 Years
> 25 Years

5. What is the age range of the Company Director?
> 40 Years
Between 30 and 40 Years
<30 Years

6. What is the Degree of the Company Director?
Up to and including 9th Year
Higher than the 9th Year but does not have the 12th full year
12th Full Year
Higher Bachelato Degree / Degree) or attendance at any higher education institution

7. How many employees work in the Company (Productive + Non-Productive)?
1-4
5-10
11-15
16-20
21-40
40-250
> 250

8. Does the company work with freelancers?
1-4
5-10
11-15
16-20
21-40

9. Who usually makes purchases of machines, products and raw materials for the company?

General Director of the Company Responsible for Purchasing
Other (please specify)

10. What is the age range of Purchasing Manager?

> 40 years

from 30 to 40 years

<30 years

11. What is the School degree of Purchasing Manager?

Up to and including 9th grade

Over 9th grade, but under 12th

12th grade

Higher level (Bacherelato / graduation) or frequency in some higher education establishment

12. In the last year, did you attend any training?

Yes.

No

13. If the previous answer is yes, the training was related to:

Environment

Stock / Financial Management

Search and Selection of Suppliers

Compliance with regulations

Other (please specify)

14. At the time of Buying the products, what do they value most in the choice of the Supplier?

Price, Price / Quality, Ecological Products

15. What is the secondary factor in the selection of materials to be purchased?

Price, Quality / Price, Ecological Products

16. How does the supplier selection process work?

We only buy from suppliers who represent products that are duly certified.

Selection according to the reception of suppliers

Moderate Vendor Renewal Search

We keep the same suppliers where possible.

17. What kind of products do you produce most often?

Magazines / Newspapers

Advertising / informative brochures

Letterhead

Other (please specify)

Books

Forms

Custom Packaging / Boxes
Posters / Outdoors

18. Of the following equipment and technology, which are those that the company owns and uses regularly in printing and finishing processes?

Typography
Serigraphy
Other (please specify)
Offset
Flexography
Digital Small Format
Digital Medium Format
Digital Large Format

19. In Offset Printing with what format do they work?

Small format (1 colour)
Medium format (2 colours)
Large format (4 colours)
Rotative (> 4cores)

20. What kind of ink do you use for offset work?

UV Drying
Oxidation Drying
Other (please specify)

Falta aqui:

29. What concerns does the company usually have in selecting the type of paint to be purchased?

The effects of the ink on the health of employees and the customer are taken into account.

In addition to price and quality, the toxicity of ink constituents is analyzed.

Best price / quality ratio.

Ink toxicity is placed ahead of any other selection parameter.

The fastness and drying method are the main selection parameters.

21. What is the percentage of alcohol used in the mixture?

0 -3%
4 - 6%
> 7%

22. How do you usually deal with the plate resulting from Offset jobs?

Metal scrap
Pick Up by Certified Company for recycling
Miscellaneous Scrap
Other (please specify)

23. How do you usually deal with Offset fabrics?

Pick Up by Certified Company
Common Trash
Selective Waste
Other (please specify)

24. Do you have a catchment basin in the cleaning areas?
Yes, in whole or in part
No not at all

25. What is the destiny of the waste from the catchment basin?
Certified Pick Up
Other (please specify)

26. What is the concern that the company has in general with the Environment?
Very High
High
Average
Reduced
None
Falta aqui
Qual a preocupação da empresa com a qualidade do ar nas suas instalações?

27. How does the company demonstrate its care with the environment?
Careful selection of the products you use
Selective Pick Up of some effluent
Selective Pick up of all effluents
Pick Up of all Solid Residues
Pick up of some solid waste

28. Is the Company certified by any normative reference?
ISO 9001
ISO 14000
ISO OSHAS 18000
Other (please specify)

29. What concerns does the company usually have in selecting the type of paint to be purchased? (Indicate the answer that best fits the reality of the company).
The effects of the ink on the health of employees and the customer are taken into account
In addition to price and quality, the toxicity of ink constituents is analysed
Best price / quality ratio
Ink toxicity is placed ahead of any other selection parameter.
The fastness and drying method are the main selection parameters

30. What are the concerns of the company in terms of health of its employees and hygiene, safety and healthy work posts (check all that are in accordance with the general practices of the company)

- 30.1 Collaborator responsible for monitoring company HSS situations
- 30.2 External company responsible for monitoring HSS situations
- 30.3 Periodic training of the company's middle management
- 30.4 Periodic training to all employees
- 30.5 Continuously connected air renewal in the company
- 30.6 There is no forced air renewal in the company.
- 30.7 Employees have all the elements of individual protection, necessary and are encouraged to use them
- 30.8 Employees have all the elements of individual protection, necessary but not encouraged to use them
- 30.9 There are no PPE
- 30.10 The collaborators are warned of all the dangers inherent in their professional activity

Igual à 28

32. Business volume in the last year in (€)

Until 100000

100000 a 250000

250000 a 500000

500000 a 1000000

1000000 a 2500000

2500000 a 5000000

>5000000

33. Have you recently or are you planning on making new equipment investments in the next 2 years?

Yes

No

34. When was the last time you purchased new equipment?

1 year

2 to 4 years

5 to 7 years

8 to 10 years

> 10 years

35. For what kind of market do you manufacture mostly?

National

Mixed

Foreign

36. What kind of market is most preponderant for the company?

Restoration

Other (specify

Diverse market

Large areas

37 Business management

National

Foreign