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THE IMPORTANCE OF DATA ANALYSIS IN THE MODERN ERA OF PRINT PRODUCTION

Christos Trochoutsos [1,2,3], Yannis Sofias [4]
[1]HELGRAMED - The Hellenic Union of Graphic Arts & Media Technology Engineers, Athens, Greece
[2]Hellenic Open University, School of Applied Arts, Patras, Greece
[3]PressiousArvanitidis printing company, Greece
[4]University of West Attica, Greece

Abstract: *As the role of digital transformation becomes multi-fold in every sector, it generates huge amounts of information that can yield valuable insights at all fields of business and production activity. This has led to an expansion regarding the necessity of data handing and processing.*
Industry 4.0 is the current trend on automation and data exchange in manufacturing technologies. The elements that are included in Industry 4.0 create the so-called "smart factory" concept which indicates the direction towards the total transformation processes for all industries.
Data analytics, following data collection, storage and handling, has become a crucial component of any business management system as an integral tool for creating strategies in all major organizations. The printing industry -of course- is not an exception to this rule. Analytic tools are embedded in all major MIS (Management Information Systems) and data are collected throughout the production from prepress to postpress departments.
The present paper investigates the structure and formation of data from print management and production and the way that these can be used for providing actual and accurate information for the total business operation of a printing company.

Key words: printing industry, digital transformation, smart printshop, industry 4.0, data analytics, business intelligence

1. INTRODUCTION

The importance of data analytics in any sector is compounded, creating enormous quantities of knowledge that can provide useful insights. And these insights are needed for further production and growth. According to many, digital transformation is not just a current trend for all businesses. It is a survival issue. The pandemic period made clear a fact that was also known before COVID-19: each organization needs to have the ability to adapt quickly to supply chain disruptions, time to market pressures and rapidly changing customer expectations. For all these critical facts and company decisions, one must take consideration of all data analytics (The Enterprisers Project, 2016).
Data analytics applies generally to all processes and resources necessary for the collection and analysis of critical data. For all businesses to achieve a strategic edge, data analytics play a vital role for three main purposes:

- Product Development: data analytics offer estimation and exploration capability for information and provide a good understanding of the market or current state, while offering a solid base for forecasting future results.
- Target Content: for improving consumer orientation in campaigns, figure out which client case group responds to the initiative and thus increases the overall performance of the marketing activities.
- Efficiency in Operations: data analytics helps find more viable ways to streamline operations, recognize possible issues and act on them (Ohri, 2020).

In order to improve any operation, relevant data needs to be collected, either from the production itself or where else is needed. Organizations usually gather data from employees, companies, industry, and realistic expertise.
The first step is to determine the data requirements or how the data is grouped. The second step in data analytics is the process of collecting it. This can be done through a variety of sources, nowadays with

numerous IoT devices that can collect and send data in real time to a specific server or online platform. Once the data is collected, it must be organized so it can be analyzed. Usually, the software that is responsible for collecting the data also provides some out of the box insights that can be useful. There will be a use case at the end of this research.
In the printing industry, as in all other businesses, data analytics also help the optimization of the processes, so companies can help reduce costs, make better decisions and help analyze customer trends and satisfaction, which can lead to new –and better- products and services (Frankenfield, 2021). For example, data in the field of graphic arts that may be useful to be collected are ink level, ink consumption, setup per operation, idle time between operations, quality control metrics, scrap materials, warehouse information, inventory turns, printing speed of the machines, factory environmental conditions, product mean time in the warehouse, number of orders per day, availability of paper etc. With the use of data analytics, it is also possible to apply specific Artificial Intelligence (AI) algorithms so to foresee not only cost reduction and more efficient productivity, but also minimize environmental footprint by extending into a circular economy strategy.

2. INDUSTRY 4.0 AND BIG DATA

Industry 4.0 is often connected with digital transformation. And digital transformation is not only a high trend of the latest years, but the main procedure that a company needs to follow to stay competitive, grow up, survive. This is a lesson obtained from the last three years, due to COVID-19 pandemic where a high acceleration took place in adoption of digital technologies and digital transformation in all businesses and society.

2.1 Industry 4.0 and Printing Companies

According to Heidelberg (Heidelberg, 2022) just like Bill Gates and Steve Jobs, the early printers were also revolutionaries; hence nowadays printers face the challenge of revolution, with the use of digitalization of the printing industry. The last one is particularly affected for two reasons: on the one hand, printed media and material have become less important in the face of digital communication and on the other, the digital transformation is moving the goal posts when it comes to competition. The time has come to start making decisions driven from data collected and take advantage of any new business opportunities.
At the heart of industry 4.0 (Figure 1), there are themes that differentiate it from previous revolutions and highlight the main ideas surrounding it. By just naming them, these are:

- System Integration, which refers to the integration technologies that connect disparate parts of a company's slack together as well as third party solutions.
- Simulation and virtualization. Simulation is used in MIS solutions (which is widely used in graphic arts business) to compare the different production routes available and present the most cost-effective method of production. Virtualization can be used in a similar way by adding a virtual press, so the user can see how it affects the costs and help him make a purchasing decision.
- Internet of things. The most common usage in graphic arts is the warehouse, by adding RFID tags to provide read time visibility of the supplies.
- Cloud technologies have become more popular as an option to provide remote access to both employees and users.
- Autonomous robots. Although in its early stages in the graphic communication industry, there has been some adoption of machines, mostly used in the warehouse.
- Additive manufacturing: Typically, 3D printing to create working prototypes or replace parts. (Highman, 2021)

Figure 1: Themes at the heart of Industry 4.0

- Big Data & Analytics. Big Data refers to the analysis of extremely large and complex data sets to reveal patterns, especially (but not only) relating to human behavior. For example, in a typical offset printing company, data collection and data storage are taking place from various sources and operations, in order to enable intelligent decisions. This data can originate from:

- MIS: large amount of data, collected across the various departments including ink level, idle time between products, results from color spectrophotometer, scrap material, warehouse information, printing speed of the machines, factory environmental conditions, product mean time in the warehouse, number of orders per day, availability of paper.
- CRM/ERP systems: useful data can be analyzed to better understand a client's wants, needs and preferences and then these data can be used in marketing dept, to personalize direct mail and advertising.
- From production and operation: information about defects can be also analyzed, such as time and frequency of occurrence, fault reasoning, percentage of wasted resources, estimated financial loss etc.

Applying proper AI algorithms in the analyzed data, a company can foresee not only cost reduction and more efficient productivity, but also minimize environmental footprint. Therefore, this leads to the so called "Smart Print Factory", where all the above information is handled, allowing data to be constantly shared and analyzed through the connection of machines and production systems.
Yet, the Smart Factory is just one milestone (as Heidelberg suggests) because digitalization refers to enabling or improving processes by leveraging digital technologies and digitized data. Digitalization improves an existing business process or processes but doesn't change or transform them. That is to say, it takes a process from a human-driven event or series of events to software-driven. Digital Transformation on the other hand is really business transformation enabled by digitalization. Thus, the essence of digital transformation is the changing of business processes enabled or forced by digitalization technologies (Naik, 2020).
Concepts such as the smart print shop take a holistic approach to the value chain and demonstrate how the combined use of efficient workflows, IoT (connected machines) and data-based performance optimization can unlock potential in terms of productivity and costs. Despite that, the objectives associated with the Smart Print Shop can meet only some of the challenges of print industry digital transformation.

2.2 Data analytics / business intelligence

As a company's level of digitalization increases, huge volumes of data are generated. This is referred to as big data. If big data is to be used to control operations or to develop and monetize digital business models, the available data needs to be complete, centralized, and of a high quality. Only then does it

provide a true picture of the actual circumstances, which is in turn a prerequisite for reliable analyses and forecasts, and for efficient operational control.
However, most big data is nothing more than raw data. Only if this wealth of data is provided on a cross-company basis for data analytics solutions does it become valuable information and the driving force behind a data-driven organization. And only then can decision-makers use evaluations to react to changes quickly and confidently. The structured collection and analysis of data also creates transparency regarding purchasing processes and customer activities throughout the digital customer journey. The resulting in-depth understanding of customer behavior and expectations can be used to optimize offerings, products, and business ideas on an ongoing basis.
For printshops, transforming data into actionable intelligence can mean the difference between struggling and thriving. Maximizing the value of information requires data analytics: the process by which raw data is analyzed to reach conclusions.
In terms of Industry 4.0, data analytics focus on “what will happen” rather than “what has happened”. These problems are entitled as predictive analytics and aim at building models for forecasting future possibilities or unknown events. Data Analytics helps printshops to get actionable insights resulting in smarter decisions and better business outcomes (Jain, 2017). For this reason, data analytics is becoming a very attractive topic for almost every manufacturing firm in Industry 4.0 era.
Understanding data at a deep level is critical to building a successful printshop. Data analytics is the process by which raw data becomes usable knowledge that can be acted on (Figure 2). The Analytics applications should be present at every stage of the data pipeline to make it easier for printshops to collect and analyze data for practically any purpose. Data analytics solutions can be implemented on premises but also offered as a cloud SaaS application such as the Predictive monitoring application by Heidelberg.

Figure 2: Data analysis process steps as proposed in the Heidelberg predictive monitoring solution. Recording - Analyzing – implementation – Reporting

While almost every organization analyzes data, modern analytics enables an unprecedented level of understanding and insight. How far has your company gone toward a data-led, analytics-driven culture—and what’s the next step? It all starts with the data pipeline (Intel, n.d.).
The data pipeline should include the following 4 stages:

- Ingestion: Data Collection
- Preparation: Data processing
- Analysis: Data modelling
- Action: Decision Making

Furthermore, Data analytics can be divided into four basic types: descriptive analytics, diagnostic analytics, predictive analytics, and prescriptive analytics. These are steps toward analytics maturity, with each step shortening the distance between the “analyze” and “act” phases of the data pipeline.

2.2.1 Descriptive Analytics

Descriptive analytics is used to summarize and visualize historical data. In other words, it tells the printshop what has already happened. The simplest type of analysis, descriptive analytics, can be as basic as a chart analyzing last year’s sales figures. Every analytics effort depends on a firm foundation of descriptive analytics. Many print companies still rely primarily on this form of analytics, which includes dashboards, data visualizations, and reporting tools.

2.2.2 Diagnostic Analytics

As analytics efforts mature, organizations start asking tougher questions about their historical data. Diagnostic analytics examines not just what happened, but why it happened. To perform diagnostic analytics, analysts need to be able to make detailed queries to identify trends and causations. Using diagnostic analytics, new relationships between variables may be discovered: Rising sales figures in a customer segment may correlate with a certain periodic fact. Diagnostic analytics matches data to patterns and works to explain anomalous or outlier data.

2.2.3 Predictive Analytics

While the first two types of analytics examined historical data, both predictive analytics and prescriptive analytics look to the future. Predictive analytics creates a forecast of likely outcomes based on identified trends and statistical models derived from historical data. Building a predictive analytics strategy requires model building and validation to create optimized simulations, so that business decision–makers can achieve the best outcomes. Machine learning is commonly employed for predictive analytics, training models on highly scaled data sets to generate more intelligent predictions.

2.2.4 Prescriptive Analytics

Finally, an advanced type of analytics is prescriptive analytics. With prescriptive analytics, which recommends the best solution based on predictive analytics, the evolution toward true data-driven decision-making is complete. Prescriptive analytics relies heavily on machine learning analytics and neural networks. These workloads run on high-performance computers and memory. This type of analytics requires a firm foundation based on the other three types of analytics and can be executed only by companies with a highly evolved analytics strategy that are willing to commit significant resources to the effort.

2.3 Company holistic transformation

In the future, the most successful commercial and packaging printers will be the ones who make their processes leaner and faster, who get more out of their data, and who can adapt more effectively to the needs of customers with an increasingly digital setup. All that requires new ways of thinking and working, which in turn demands an understanding of the key technologies and their potential for the printing industry.

Digital transformation and implementation of a smart printshop ecosystem based on industry 4.0 and Lean manufacturing practices is not a readymade product or a one-and-done project or just another IT initiative. To truly keep each company competitive and adaptable, it is necessary to adopt a holistic approach. As Hartl and Hess claim (Hartl & Hess, 2017), the rapid advancement of digital technologies has fundamentally changed the competitive dynamics of industries. To cope with an increasingly unstable environment and to fully leverage the opportunities opened by new technologies, organizations need to transform their businesses. As such, digital transformation initiatives are prevalent throughout industries, yet often experience failure due to inert organizational cultures preventing change.

Digital transformation differs from any other IT-enabled business transformations in its holistic nature and speed. Therefore, change is an inevitable part of every organization's life due to our rapid global, economic, and digital developments. Change and transformation are crucial for building an organization that can thrive in the digital age. Furthermore, digital transformation requires fundamental changes in an organization, including structure, processes, strategy, and culture (Vial, 2019).

In terms of organizational changes as a part of digital transformation, small and small to medium enterprises SMEs are often, by nature, more flexible, faster, and less constrained than larger companies (Barann et al., 2019). However, their size also poses some noticeable constraints for evaluating and implementing digitalization opportunities, including potential knowledge gaps and limited resources.

The printing industry in Greece is consisted of micro, small and SME companies that face pressures resulting from rapid changes in technology and market environment. In many cases they need transformation to grow or to cope with evolving competition. They often need to transform their strategic business approaches, including implementation of new products and increasing business models efficiency. Printshops share certain qualities such as high independence, superficial structures, direct company relations and natural flexibility of action. These qualities may influence the organizational

culture (Klat & Matejun, 2012). Moreover, cultural factors support or oppose digital transformation. However organizational cultures embracing people- and development-oriented values were the most supportive for successful digital transformation adaptation and implementation (Leidner & Kayworth, 2006).

3. CONCLUSION

While many printing companies have made significant progress with their digitalization efforts, smaller companies are still struggling to find and implement a workable digitalization strategy. Accordingly, the challenges they face are different, too. The task confronting those companies that are lagging behind is normally to bridge fundamental digitalization gaps by replacing outdated technology and modernizing processes that are still analog. Other businesses have been investing in the relevant technology for years but are struggling to adapt their business model, while others still, despite having the latest technology and an innovative business model, are unable to find a viable operating model.

These few examples alone demonstrate that there can be no one-size-fits-all digitalization strategy. Each company needs to find its own way based on its strengths and its goals. Often, the best way of establishing what is possible and makes sense is to bring in external experts with proven industry experience. However, it is vital to aim for a holistic strategy from the outset – even if a new or modified digital organization initially takes shape little by little and point by point, something that is strongly recommended.

If digitalization is the leveraging of the processes and information themselves, digital transformation is the sustained implementation of new business practices enabled by digitalization. Digital transformation should start with manageable projects and defined subgoals to limit the expense and the resources required. This approach removes any risk from ongoing operations, while also encouraging acceptance among management and other staff. Rather than being achieved through single ground-breaking solutions, a successful transformation is based on the orchestrated interaction of various solutions.

Another important consideration is that Lean manufacturing philosophies and continuous improvement processes first need to be implemented to unlock the full potential of digitalization. If these prerequisites are met, nothing further stands in the way of successful digitalization.

Even after 30 years of the Internet economy, do printing companies still have time to switch to systematic digitalization? Time is running out, though, because increasingly – unlike in the analog/traditional business world – the winner takes it all in the Internet economy. Anyone who fails to make the transition or delays doing so, runs the risk of becoming a victim of the digital era. For industrial settings such as the printing industry, that means the time to act is now.

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