

# Enterprise Systems in Print Production Workflow

Muhammad Yusuf Masod<sup>1</sup>, Siti Farhana Zakaria<sup>1</sup>, Sebastianus Adi Susanto<sup>2</sup>

<sup>1</sup> Department of Printing Technology, Faculty of Art & Design, Universiti Teknologi MARA, 40450 Shah Alam, Malaysia

<sup>2</sup> University of Stikubank, Kota Semarang, Jawa Tengah 50249, Indonesia

yusuf595@uitm.edu.my, farha981@uitm.edu.my

**Abstract** — Operations in a printing company are complex, whereby numerous entities, resources, and processes are involved in completing a single job. The parties in a transaction often include customers, material suppliers, external service providers, and shipping/delivery companies. On the other hand, production resources consist of equipment, employees, and materials, whereas production processes comprise prepress, press, and post press activities. Typically, the cycle of a job begins with sales and customer service, and ends with the accounting department generating an invoice and processing the payment. In between, other departments perform services that are critical to the job cycle, but are not directly involved with production. The introduction of enterprise systems in print production workflow is to assist and improve business operations. Web-to-print system, Print Management Information System (MIS), and PDF workflow system are recognized as the most important systems in print production workflow. To achieve maximum benefits, assessing the needs and choosing the right print production system are profound planning activities before commencing the initial implementation phase.

**Keywords** – Enterprise System; Web-to-print system, Print Management Information System (MIS), PDF workflow system, Print Production Workflow

## I. Introduction

Initially, the introduction of enterprise systems in print production workflow in the printing business process was to document, automate, streamline, and provide feedback on time and cost of print related products and services (M. Glykas, 2004; Baray, Hameed, & Badii, 2006; Yang, Liu, & Shi, 2010; Lin, Zeng, Hoarau, & Dispoto, 2010). The aims of the workflow were to address ongoing issues in print production, increase interoperability (information exchange), and provide a framework to support non-print related products and services. Existing literature suggests that enterprise systems in print production workflow are focused on the production areas responsible for estimating, order entry, customer service, scheduling, prepress, and billing (Caldas, 2003; Ramakrishna, 2003; M. Glykas, 2004; Baray, Hameed, & Badii, 2008; Grabski, Zhong, Peng, Xiao, Zhang, & Cheng, 2010a; Leech & Schmidt, 2011). There is a lack of research on enterprise systems in print production workflow. Thus, this study aimed to recognise the significance of enterprise systems in print production workflow, namely, web-to-print system, Print Management Information System (MIS), and PDF workflow system. These systems have overcome bottlenecks and pain points in print production areas; however, the lack of interoperability often results in islands of automation (Punnamee Sachakamol, 2005; Dezdar & Sulaiman, 2009; Yao & Lin, 2016). Besides that, only a few manufacturers have addressed the issue of interoperability. Instead, most manufacturers have focused on user issues such as: multifaceted workflows; integration issues; Customer Relationship Management (CRM) integration; job floor tracking and actionable data; and mailing, fulfilment, and inventory management. Interoperability and support for value-added products and services with the integration of database or marketing services is the future of workflows. Nonetheless, research on addressing interoperability issues are lacking. Furthermore, only a limited number of companies see workflow as an application environment. Johannes (2013) and Perey (2011) have suggested using Application Programming Interfaces (API) to address interoperability issues which allows communication between systems. This capability does not exist in most of the legacy systems and as a result, companies need to rewrite the program code. Lack of interoperability leads to a huge gap in the workflow, hence, the need for a workflow system that can communicate with the non-traditional workflow system, which may be managing non-print services such as content or digital asset management, data or campaign analytics, and cross media production.

## II. Print production workflow

Workflow can be defined as a linear sequence of events that produce a desired goal (Agrawal et al., 2011; Bingzhong, Xiaoli, Wei, Huanen, & Xuyan, 2013; Bogart, 2009; Cummings & Borlado, 2009; Duan et al., n.d.; Y. C. Hsieh & Lin, 2010a; Y. Hsieh & Lin, 2011; Veglis & Pomportsis, 2009; Zeng, Lin, Hoarau, & Dispoto, 2010). With computer-to-plate (CTP) equipment, systems were included to assist the production of printing plate. The term workflow system was first used to describe the prepress task, as depicted in Figure 1.



Fig. 1. Prepress task.

As illustrated in Figure 2, the definition of workflow system has evolved, with the introduction of web-to-print system and Print MIS in the extended version. The CTP workflow system was then replaced by PDF workflow system.



Fig. 2. Workflow automation in three print workflow system

Workflow automation encompasses three print production workflow systems, as shown in Figure 2. Automation comprises any tools that mechanize any step in the print production workflow, as demonstrated in Figure 3.



Fig. 3. Steps in print production workflow.

Production workflow analysis is crucial to include more tasks and other print and non-print products and services. Many researches have highlighted the workflow management technique, Lean and Six Sigma, as a process improvement strategy to reduce bottlenecks and quality control issues, and identify opportunities for improvement in print production workflow (Roth & Franchetti, 2010). In general, quality control issues result in rework and can be identified either in an inspection step or when a task needs to be reworked. On the other hand, a bottleneck occurs when the demand exceeds the capacity. Bottlenecks can happen anywhere and are relatively easy to identify because typically, there will be a pile of work sitting in that area, which is also termed work in process. Figure 4 represents bottleneck of a pile of work in process in the customer service area.



Fig. 4. Bottleneck in the customer service area.

In the process improvement efforts, identifying and measuring the impact of bottlenecks and quality control issues are critical. These can be achieved with shop floor collection data systems, which connect to Print MIS.

### III. Print Production Workflow System

The term workflow system was first introduced with CTP equipment. CTP eliminated the manual film workflow process that was required to make plates for offset printing. In the beginning, 1-bit TIFF and PDF competed to become an industry standard (Masod & Ahmad, 2013). Consequently, PDF workflow became the de facto workflow and the first tasks to be automated were trapping and imposition. Three major categories of system products were designed to streamline workflows and reduce or eliminate time consuming steps in the process. These include web-to-print system, Print MIS, and prepress PDF workflow system. These systems were designed to automate tasks. Moreover, with systems, productivity can be improved, in which 25%–100% increase in productivity was noted (Christofi, Nunes, Chao Peng, & Lin, 2013).

### IV. Web-to-print

Hsieh & Lin (2010b) classified web-to-print as a system and a service. In recent times, web-to-print has become a new trend in the printing industry all over the world. It combines the advantages of internet with printing processes in a highly digitalized way. Four different functional dimensions of the web-to-print platform focus on providing product information, successful cooperation, sharing, and administration. The fundamental functions of web-to-print include ordering/reordering, file submission (document and artwork files), proofing, credit card payments, and shipping options. With advanced features, the functions may also consist of integration of shipment, template based design (inputting name, address, and phone number into business cards), variable data printing (VDP), preflight, and the ability to upload a database of names for VDP printing. Integration is a main concern in the web-to-print system and Print MIS, for instance, to integrate billing and estimating. Web-to-print system offers credit card billing but may not share that information with the Print MIS, which often provides the balance of billing. Additionally, the web-to-print system generally requires data entry of pricing. Nevertheless, Print MIS is commonly used to generate estimates and a more efficient workflow would allow the estimating data to automatically populate the web-to-print pricing. To overcome this, printers should opt for a developer from the same company. Progress has been made with some specific companies and products. Besides that, a site visit should be requested from the company that highlights integration works. Some of these solutions also offer warehousing and fulfilment tracking.

### V. Print Management Information System (MIS)

Managing company administrative tasks such as estimating, job ticketing, scheduling, and billing, is the primary aim of implementing Print MIS. Often, modules for other features can be purchased separately or turned on when needed. The more advanced features include job floor tracking, large-format estimating, fulfilment, shipping, and customer relationship management. Although Print MIS is one of the longest available products, this system is also controversial. Many studies have highlighted issues in the implementation of Print MIS (Artit, 2012; Baray et al., 2008; Chen, 2001; Christofi et al., 2013; Jenatabadi, 2014; Prodromos Chatzoglou, Dimitrios Chatzoudes, & Leonidas Frigidis, 2008; Xia, Yu, Lim, & Hock, 2010). Besides, market research studies conducted between 2012–2015 by National Association for Printing Leadership (NAPL), had quoted customers as saying that they were satisfied when the system worked and provided them with the information needed to manage their business. However, they were unhappy when manufacturers discontinued products, ceased providing product support, or asked for high fees to upgrade Print MIS to the latest version. Print MIS is a system that is most often tailor-made. According to a 2014 Keypoint Intelligence/InfoTrends study entitled 'US Production Software Investment Outlook', companies reported that they created their own Print MIS solutions 27.0% of the

time, compared to using tailor made web-to-print solutions (20.5%) and prepress workflow system (21.0%), while some of them use customised worksheets (i.e., MS Excel) for estimating, scheduling, and billing.

## **VI. Portable Document Format (PDF) workflow**

Prepress PDF workflow system was introduced with CTP equipment with the aim to automate prepress tasks such as colour management, trapping, and imposition. An automated PDF workflow uses hot folder strategies that allow staff to automate each task and then transfer the file to the next hot folder to perform the succeeding task without human intervention. In comparison to web-to-print system and Print MIS, there are limited innovations within the PDF workflow system. The most profound innovation is a universal workflow that allows files to be created in the prepress workflow system to be used with CTP systems and digital printing presses. This development is seen as a solution to address the multiple work issues. Nonetheless, complexity arises in the digital press workflow when there is a requirement to mix media from multiple trays and assign in-line finishing.

## **VII. Job Definition Format (JDF)**

Job Definition Format (JDF) is the core standard of computer integrated printing, which is a technical standard developed by the printing industry to facilitate cross-vendor workflow implementations of the application domain (Zhong, Peng, Xiao, Zhang, & Cheng, 2010b). The JDF language is used to communicate across different manufacturers regarding everything from equipment setup to confirmation of pages inserted and pieces mailed. Typically, the pen and paper job docket method was used as a formal document to transfer specifications and instructions to different operators in the workflow. As an XML-based file format, JDF bridges the gap across the internal languages used by different manufacturers to a common language used by everyone. The application of JDF can be seen in prepress, whereby JDF information is stored in a Print MIS and sent with a PDF file to a PDF workflow system to instruct the system on how to trap and impose the files. JDF information that contains sheet fold and trim instruction could also be sent to the finishing equipment. If the finishing equipment has the capability to scan barcodes, it could then send feedback to the Print MIS system about individual pages folding into envelopes or the total number of envelopes mailed.

## **VIII. Variable data printing (VDP)**

VDP encompasses on-demand digital printing that produces customized or personalized documents targeted to an individual or groups of people (Cummings, 2008; Lin et al., 2010). Elements such as text, graphics, and images in a single document are changed from one printed page to the next based on an individual's information from a database. This is an effective way to increase response rates, sales, and customer engagement. The complexities of VDP depend on the amount of data to be embedded into a document. The simplest one may include only name and address details whereas a more complex one may involve demographic information, past purchase, and information from social media to create customized pieces. Mastering VDP is an added advantage for companies in offering marketing services. Not only that, mastering web-to-print and VDP is considered a stepping stone in the process of delivering more marketing services.

## **IX. Conclusions and implications**

The application of enterprise systems in print production workflow has a positive impact on business operations, especially in printing companies. Nevertheless, difficulties arise when an attempt is made to implement them. Various studies have highlighted that enterprise systems are expensive, profoundly complex, and notoriously difficult to implement (Baray et al., 2008; Chen, 2001; Christofi et al., 2013; Xia et al., 2010). Therefore, the probability of failure has always been high. Firms have truly recognised and addressed the planning issues to gain the benefits and prevent major impediments. Hence, assessing the needs and choosing the right print production system are vital in planning the activities before commencing the initial implementation phase. This is in contrast with the implementation of less sophisticated technological innovations such as computer-aided design/manufacturing and manufacturing resource planning. In many wide ranging investigation on the critical success factor for implementation, Umble, Haft, & Umble (2003) concluded that bypassing critical steps of business implications and simplifying their processes contribute towards unsuccessful implementation. Due to the dynamic nature of the printing business process and the lack of research in this field, future studies should focus more on intricate planning issues, in which organisations will learn about new business processes and enterprise systems. Consequently, behavioural changes that are needed to support the new way of doing business which are crucial in providing unprecedented competencies, will be recognised. Ultimately, enterprise system-enabled business processes that evolve will benefit organisations that take the time and effort to grow with them.

Organisations that continue to learn and transform their behaviour as needed is the only sustainable source of competitive advantage in the near future.

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