

# Design of Web Content Management System for Dental Laboratories

Reham Alabduljabbar and Samir El-Masri

Department of Information Systems, College of Computer and Information Sciences, King Saud University  
Riyadh, Saudi Arabia

## Abstract

Web Content Management system is a management tool for creating a dynamic website. It ensures logical structure of data organization and ease of content accessing and presenting. Dental laboratories need Web Content Management system (WCMS) to control their business. Maintaining a long-term relationship between dental laboratories and their customers (dental clinics and dentists) urges an active communication process between the two sides. The main contribution of this paper is to design a simple Web Content Management System for Dental Laboratories. The system adopts three layers of technical architecture. The paper will also discuss why there is a need to develop a standalone WCMS for Dental Laboratories whilst other open source WCMSs can be utilized such as Joomla, Drupal and WordPress.

**Keywords:** *Web content management system, Dental laboratory system, Three-tier architecture, Commercial content management system, Open source content management system, Joomla, Drupal.*

## 1. Introduction

Not all dental clinics have their own dental laboratories. Small to medium clinics send their patient lab cases to local, national or sometimes international dental laboratories. Communication is done through mailing handwritten forms or sending files and bills by email. Usually each dental clinic works with one dental laboratory. However, dental laboratories receive lab cases from different dental clinics. a long time is wasted at both sides on trying to track down missing lab case information over the phone or email, working out unreadable handwritten prescriptions, or following up on billing and payments.

Maintaining a long-term relationship between dental laboratories and their customers (dental clinics and dentists) urges active communication process between the two sides.

According to the Marketing Director at the Continental Dental Laboratories<sup>1</sup>: “communication—or a lack of it—will make or break the relationship between a laboratory and the dentist”.

<sup>1</sup> <http://www.continentaldental.com>

Until now, this communication process is done through a handwritten prescription and an impression that may or may not have been able to completely give the required information to the technician to meet the dentists' expectations.

Vice President, Sales & Marketing at Trident Dental Laboratories<sup>2</sup> agrees that the fewer laboratories have to depend on verbal or written instructions, the better. The laboratory work depends on the prescription form received from the clinic, any simple mistake or incomplete information will result in loss in money and customers [4].

It is not only about lab case management, the dental laboratory, the dental technicians, and the laboratory owner have an obligation towards dentists to share their knowledge with them and to educate them regarding new products. Whether for product education or case management, communication between the dentist and the laboratory is the most important factor that has a great influence on the success of the relationship [4].

The market is crowded with desktop applications for managing dental laboratories operation; however, we are looking for a system that utilizes both case management and a relationship between dental laboratory and its customer. Many information need to be shared between dentists, dentist assistant, laboratory technicians, laboratory owner and others. With the development of the Internet technology, there is a need for an effective web application to manage such operation and to control accessing this shared information. Thus, the motivation of this paper is to design a simple Web Content Management System (WCMS) for creating dental laboratories websites.

<sup>2</sup> <http://www.tridentlab.com/>

Figure 1- Requesting Lab Case Form

The dental laboratory web content management system provides service to the dental clinics located in different locations. It would be used as a channel for dentists to technician, dental clinic-to-dental laboratory, to provide the long-term relationship and information sharing.

In daily services, a dentist in a certain clinic fills a form as in Figure 1 to order a lab case from a certain dental laboratory. Then, the dental assistant and other staff arrange with the laboratory for pickup, payment and delivery. This paper-based recording imposes several major drawbacks namely miscommunication between the laboratory and the clinic and lack of visual interactivity.

With dental laboratory WCMS, the medical data, pictures and patient records all can be accessible online. Dental laboratories can track and manage lab cases and payments online. Besides, dental clinics and dentists can access to track the lab cases, and they can be notified by email about the status of their lab cases. Both have an account and can view their lab case history, their current balance, and pay bills online. It aids in reducing paperwork and automating the approach to process lab cases.

Any dental laboratory can have its own instance of the system to manage its content and to ease communications with dental clinics its working with. The basic idea of web content management systems is to get organized and find a logical, consistent and easy way to place content on the web [8]. It allows non-technical users to create, edit, manage and control a

large, dynamic collection of web material (HTML documents, images and video). WCMS involves a lifecycle starting from creation to destruction of content. The lifecycle includes reviewing the content before publishing it and it may include archiving before destroying. WCMS helps in keeping the site more consistent, ease the navigation, and most important it aids in controlling and tracking the content [13].

Figure 2 shows the framework for the dental laboratory WCMS. The core of this dental laboratory WCMS is the content, which is the patient lab case that is being sent from a certain dental clinic to the dental laboratory to be produced. The full content lifecycle starts from a dentist in a clinic submitting new patient lab case to the system and then, a laboratory technician is assigned to process this lab case. The content will be archived and later destroyed after delivering the patient lab case and receiving the payment.

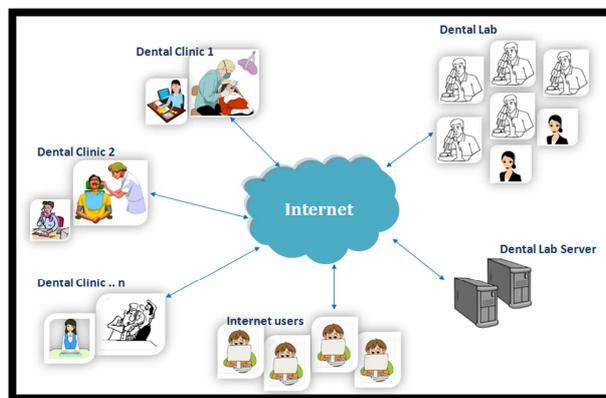


Figure 2- Dental Laboratory WCMS Framework

In the next section of this paper, a general review on commercial and open-source solutions for similar systems is given with a discussion whether there is a need to build a custom WCMS or the available open source WCMS solutions can be utilized. In the third section, the overall system analysis and design is proposed. Finally, the paper concludes with a summary of the key issues discussed in the paper.

## 2. Related Background

### 2.1 Commercial Dental Laboratories WCMS

Similar dental laboratory management systems envisaged is available on the international market in various formats, however the products available have several disadvantages. The greatest and most obvious disadvantages are:

- They are costly and usually unaffordable for small to medium dental clinics.

- They do not combine web management and content management.
- They normally do not have user friendly interface.
- They do not offer any kind of personalization or customization to their customers.
- They only offer dentist account; there is no dental clinic account.

We conduct a research and create a short list of systems in order to be further examined and narrowed or widened to fit the small to medium dental laboratories need. Table1 shows a comparison between some of the systems:

Table 1- Comparison between some available systems

			
<b>Web-based</b>	√	Only via DDX <sup>1</sup>	X
<b>On line scheduling</b>	√	√	√
<b>Rescheduling</b>	√	Only via DDX	X
<b>Patient lab case on line tracking</b>	√	Internal only	√
<b>Billing</b>	√	√	√
<b>Dentists Profile</b>	√	√	√
<b>Clinic Profile</b>	X	X	X
<b>Attaching files</b>	√	Only via DDX	X
<b>Reports</b>	√	√	X
<b>Customer Service</b>	√	√	X
<b>Chatting system</b>	X	X	X
<b>Personalization</b>	X	X	X
<b>Customization</b>	X	X	X

## 2.2 Open-source WCMS Utilized by Dental Laboratories

In addition to these commercial WCMS solutions, many open source solutions are utilized using Joomla, Drupal and WordPress. We have studied some websites which are utilized by different open-source solutions:

- Websites powered by Joomla:
  - Quest Dental Laboratory: <http://questdental.us>
  - A+ Dental Laboratory: <http://www.a-plusdentallab.com/>
- Websites powered by Drupal:
  - Vision Dental Lab: <http://visiondentallaboratory.co.uk/>
  - Mascol Dental Lab: <http://mascoladentallab.com/>
- Websites powered by WordPress:
  - ArrowHead Dental Lab: <http://www.arrowheaddental.com/>
  - Keller Laboratory: <http://www.kellerlab.com/>

<sup>1</sup> DDX is a web based system that turns Labnet into a Web-enabled application.

- Nik Dental Laboratory: <http://www.nikdentallab.com/>

Following are the common features of these websites:

- Sending a Lab Case: By filling handwritten form and schedule for pickup.
- Online Account: For scheduling a pickup.
- Lab Case Tracking: Not available.
- Shipment Tracking: Via carrier.
- Billing and Statements: Sent by mail.
- Product Education: promotes education for dentists through all the typical means, such as direct mail, journal ads, articles that they place in journals, and their Web site content.

Among all of the envisaged websites, none of them offer clinic and dentist account. Besides, they do not have a user-friendly interface. They are more likely static WebPages of mostly informational content with simple designs.

On the next section, a discussion is presented whether it is better to build a custom WCMS or to utilize an open-source solution.

## 2.3 Commercial vs. Open-source WCMS

As mentioned previously, there are many open-source solutions. Some of them are being created for many years, empowered by developers with technical background. A question may arise why we need standalone WCMSs for dental laboratories? Why dental laboratories do not utilize open source WCMSs solution? Although this is not the main goal of this research, it is worth it to bring up this discussion.

On the one hand, having a commercial WCMS specifically for dental laboratories will allow for full flexibility in developing [10]. Once it is available, many dental laboratories can utilize it instead of utilizing open-source solutions, this is because, the entire application is setup so it works exactly how needed by the dental laboratory. It will be faster to implement and associates a certain degree of safety as opposed to open-source. Moreover, it offers more support and stronger training documentation than open-source. Probably the most important concern regarding the commercial WCMS especially for small to medium dental laboratories is the cost.

On the other hand, for small to medium dental laboratories, open source WCMSs offer a low cost alternative to commercial solutions. Besides, Troubleshooting is made easier because of the technical support and online community. However, potential concern regarding the open-source solutions is the security. As the source code is available for public, attackers can use the source code to identify vulnerabilities. Thus, these systems raise significant security issues [9].

According [1] in 2011, the best WCMSs today are Joomla and Drupal. Having studied them, Drupal is the best to utilize when developing large websites with hundreds of pages but smaller websites with lesser number of pages are better developed by Joomla [2]. Drupal is not very user-friendly, terms are confusing and the admin interface is relatively poor, whilst Joomla is more user-friendly with a more active developer and designer community. With Drupal, unlimited user permissions levels can be created, but Joomla offers only three user levels (Public, Registered and Special). Drupal does not support multimedia, photo galleries by default but Joomla supports multimedia by its default editor [3]. Of course both of their developers have overcome these issues by developing modules to extend their usability. However, modules not always free or easy to install.

To sum up the discussion, both approaches the commercial and the open-source have their advantages and disadvantages. It is depending on the requirements of the system, so there is no absolute answer to which is 'best'. However, open-source WCMSs does not fit the requirements of the system presented in this paper. We need many levels of permissions with user-friendly interface, plus securing websites to handle payments.

As we will see in the next section, the system and user requirements are not supported by the available dental laboratories commercial WCMS, thus, we are designing a new commercial WCMS for Dental Laboratories.

### 3. Overall System Analysis and Design

#### 3.1 System Analysis

##### 3.1.1 Basic Requirements of WCMS

Following are the basic requirements of WCMS [5, 12, and 13]:

- Manage and deliver large amounts of unstructured material in multiple media and enable linking between the related materials.
- Provide a consistent and predictable information structure, user interface, and navigational mechanism.
- Support well-defined roles, responsibilities, and access control for various types of users e.g. retrieval only, editors, publishers, web manager, administrator etc.
- Enable workflow between authors, product managers, content administrators, editors, and system administrators.
- Provide a locking or concurrency control mechanism to prevent two people from simultaneously updating the same content.

- Enable searching and retrieval of content using the predefined business characteristics of products and services.
- Ability to archive data, and to output reports in digital and printed form.
- Providing a good scalability and portability, benefiting the extension of system function in future.

##### 3.1.2 System Components and System Users for Dental Laboratory WCMS

The system has three major types of system engines (components) similar to the system proposed on [5, 6] in addition to the data warehouse repository:

- A Content Editorial Engine provides content and repository maintenance and approval functions for different levels of administrators in the dental laboratory.
- A Content Reception Engine collects content from external sources, and then delivers it to different parts of the system for approval and publication.
- A Content Publishing Engine stores approved content and send them to different parties via different channels (such as email, fax, and text messaging). It also serves as the Web storefront of the dental laboratory for user enquiries.

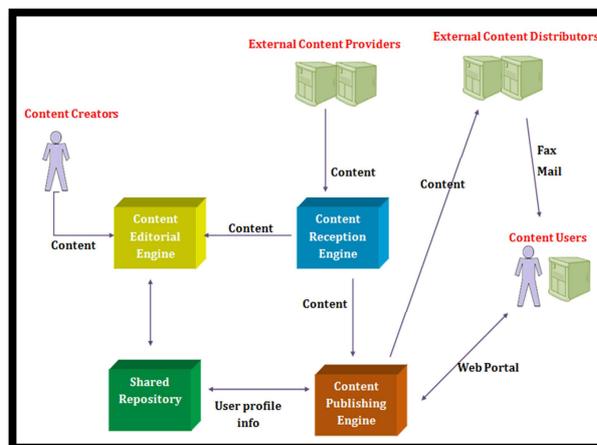


Figure 3-System users and components

Figure 3 depicts an overview of the Dental Laboratory WCMS highlighting the main system components and system users. A Dental Laboratory WCMS must be designed specifically to match the need and interest of each system user within and related to the dental laboratory.

Besides the management, there are four main types of system users involved, namely, Content Creators, Content Providers, Content Distributors, and Content Users:

1. Content Creators collectively refer to internal users who are involved in the content creation processes of the dental laboratory. The Dental Laboratory WCMS should be able to accommodate the different operational and administrative requirements of these different roles of internal users and to maintain appropriate security control. They interact mainly with Content Editorial Engines of the Dental Laboratory WCMS.
2. Content Providers are external sources (such as PayPal) providing content (such as payments) to the dental laboratory through a Content Reception Engine. To ensure timeliness, content from trusted sources are usually forwarded automatically to the Content Publishing Engine for immediate delivery.
3. Content Distributors are external service providers that render the content and deliver them to clients via different (traditional or electronic) channels, such as mass fax, mail, email, hardcopy delivery, and so on.
4. Content Users, who can be internal or external to the dental laboratory, are classified into three types in our case. Content Users obtain content access through a Content Publishing Engine. Based on their subscription data, the Content Publishing Engines also actively send appropriate content to the subscribed users. The three types are:
  - Public Visitors – Anonymous users are often allowed to access some limited amount of public content through a portal. This helps attract them to visit the dental laboratory's Web site.
  - Clients (dental clinics and dentists) – Customers who do basic business with the dental laboratory are allowed access and subscription to all unrestricted content. They have their own gateway where they can track their lab cases, pay and check their bills.
  - Internal Users – Internal staff can access "internal only" content related to them, as well as all the content for external users. They are also automatically subscribed to relevant content, according to their job functions, secretary, technician, driver, and so on.

### 3.1.3 Description of the Main System's Functions and Workflow

As mentioned earlier, the core of this dental laboratory WCMS is the content, which is the patient lab case that is being sent from dental clinic or a dentists to the dental laboratory to be processed. The full content lifecycle content creation, content editing, content approval and content publishing, which together consist of the core part of the website content management system. Following is description of each cycle:

1. Lab case creation: ability to create new lab case and submit it. In addition, content creation should provide basic editing methods and editing tools and be able to upload and download images in the content. Dentists can login using their accounts into the system and submit their cases online using an electronic form. In addition, the system will allow dentists to choose the technician if they wish. If the technician is available and able to accept the case and finish it by required time then the case will be assigned to that technician. Otherwise, the system will notify the dentist that the technician is not available and will give him/her the choice to choose someone else or just leave it for the laboratory staff to assign the lab case to a technician. Approximate pricing will be calculated after filling the form and indicating the due date for delivery. In addition, the system will offer the ability to attach files to lab cases. Dentists can attach images and any other file that is needed for better understanding of the lab case.
2. Lab case editing: editing should satisfy the requirement of submitted lab cases in terms of querying, previewing, modifying, deleting, submitting, etc. such basic operation and management, edit content items without affecting the published work and distribute the authority to approval submitted contents. In addition, lab case editing should track the process of lab case submission and approval status which has been rejected or in the process of approval. Thus, laboratory staff can view the lab cases as soon as they are submitted so they can arrange a pickup. When the lab case arrived, its status is updated as received.
3. Approval process: Approval process can add, modify, delete and manage the authority of the allocation roles and individuals. Provide a workflow that is configurable for users to allow different approval processes with varying case item status during the authoring, establish a variety of roles within a workflow process, and assign workflow to classes of content items as well as roles and individuals. The workflow in the dental laboratory will be managed by the ability to check the status of every lab case. In addition, the dental clinic will be notified by email about the status of the lab cases whether they have been received, processed or out for delivery, etc. Of course dentists can login to system and check the status as well.
4. Case approval: ability to approve the submitted lab case which is in the edit process, query and view the submitted lab cases for approval. There are two kinds of approval states: passed and not passed. The function that approval process should implement is to ensure each approval step can authorize only one approver.
5. Case publishing: The editorial content can be published after passing the approval process, in the process of content publishing, cancellation and republished function should be provided. Published content should apply static html pages as contents storage form, with the publication of the contents, the unpublished content and page module

can be updated as well, which also makes publishing Web pages convenient to manage and update. Thereby increase the speed of page browse and access. Laboratory staff will be alerted when lab cases are ready to deliver.

6. Website configuration and management: Ability to classify and manage the website columns of the publishing content, including the basic operation of the columns, such as columns add, modify, delete, as well as the template option of page modules and website columns. Besides, Website resource management can achieve the basic functions, such as upload and download files management, configuration and management of the published website parameters.
7. Rights authority: include allocation of operating authority in various sectors of system function module.

### 3.2 System Design

In the dental laboratory context, the initial structure that would be used in the WCMS had the following characteristics:

1. One central site for the dental laboratory (each dental laboratory would contain a unique domain).
2. The entire application is installed on a hosting web server for that dental laboratory.
3. A separate instance would be created for every dental clinic or dentists.

The proposed WCMS adopts Three-Tier Architecture to design the system as in [14]. Since there are many computers with different kinds of operating system will work in coordination in the system, platform independent system architecture is needed to adapt the change in future use.

#### 3.2.1 Three-Tier Architecture

The system architecture is shown in Figure 4 and is composed of three layers [11]:

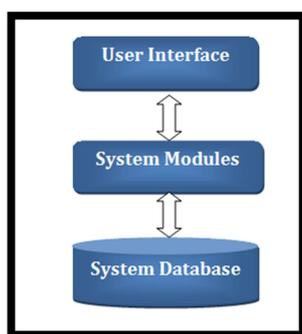


Figure 4-The system architecture

- The first (bottom) layer of the system is the database layer. It saves the system's content such as lab cases' data, dentists' data and images, etc. Content is frequently stored as XML since variety of data sources are used and each has its own characteristics [7]. XML is used to solve the incompatibility of different structures. XML facilitates reuse and enable flexible presentation options [12]. This layer mainly completes the local query, extracts and transforms distributed information from heterogeneous data sources. It uses Wrapper technology including the queries translate function and result translate function. It can translate the query result which gets from middle layer to local process. It extracts the query result and makes a XML document. Finally it returns the document to middle layer [13].
- The second (middle) layer is the system transaction layer, which is consisted of the system function modules, such as the lab case tracking. This layer mainly contains the query splitter and results Integrator two functions. In order to implement centre process, the system must use a common model which comes from different sources of information from a variety of data XML's characteristics determine that it is can describe a variety of data. It is means that it is a common data model. Heterogeneous data integration can solve this problem. It also enables the dynamic data release. Therefore, this system uses the XML model as a common model. It provides a unified query view by middleware layer on the client. It accepts the client's query command, split into various sub-queries and assigns to various data sources; and then integrates the results of its inquiries, sends to the client's browser displays for the user [13].
- The third (top) layer is the user interface layer, which included the client side of the system and displays the content to the users.

#### 3.2.2 The System Functional Structure

A well-architected application is crafted into distinct layers, each of which encapsulates a particular role. There are different functions between the layers. Each layer maintains a clear separation to make them independent existence with different tasks. But interfaces are used to communicate between different layers, shielding the implementation of the internal detail. The specific function structure is discussed below [14]:

- Content integration: Allow users to find different forms of information from different systems, and the information includes documents, data, videos, and graphics and so on.
- Content intelligent: Content intelligent is the core function module of content management system, which is used for content classification archive and help users to locate required information quickly, the search methods can be divided into full-text search and context search.
- Content management: Content management system's main function modules, to support for content management

process, including content creating and editing, achieve the access to a variety of data, information, documents and procedures and provide collaboration tools to create content.

- Content distribution: Allow all users receive the published information at the same time, including the traditional way non-Web of graphical user interface GUI, web information portal and various other ways. The specific function structure chart is shown below as Figure5.

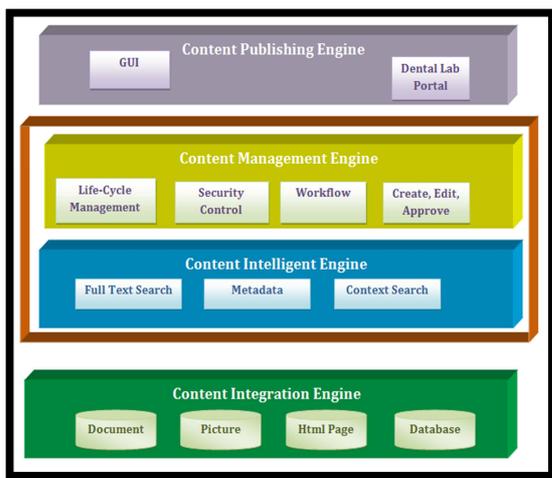


Figure 5-System Functional Structure

#### 4. Conclusions and Future Work

The paper proposed a three-tier architecture design to develop a WCMS for dental laboratories based on a study of the requirements of dental laboratories. The proposed system was designed to enhance the clinical management level and to be used as a channel for dentists to technician, dental-clinic to dental-laboratory, to provide the long-term relationship and information sharing. The system was designed for this purpose which makes it more adaptive to the industry than any other existing industry WCMS.

It is expected that in the near future, the proposed system will be developed and implemented in several dental labs in Riyadh, Saudi Arabia. The system will significantly improve performance of dental laboratories and will assure long-relationship term between dental laboratories, dental clinics and dentists.

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**Reham Alabduljabbar** Ms. Reham Alabduljabbar is a PhD Student enrolled at the Department of Information Systems, College of Computer and Information Sciences, King Saud University Riyadh, Kingdom of Saudi Arabia.

**Dr Samir El-Masri** completed his Electrical and Electronic Engineering degree at the College of Engineering, Lebanese University in 1993. Dr El-Masri has a Master's degree and PhD from the "Institut National Polytechnique de Grenoble" France in numerical simulations and software engineering in 1997. He worked for 3 years ended in 2001 at Hokkaido University, Japan as postdoctoral fellow and assistant professor. Dr El-Masri was a senior Lecturer/Associate Professor at the University of Western Sydney, University of Sydney, Central Queensland University and University of Southern Queensland, Australia from 2001 till 2006. He worked for at least 4 years in IT and software development industry at large Australian companies as a senior project manager/Program Manager and senior consultant in Australia. Dr El-Masri is currently an Associate Professor at King Saud University, Riyadh, Saudi Arabia since 2009, and he has published more than 80 research papers in international Journals, books and Conferences. Research Interests are Health Informatics. Dr El-Masri is a member of IEEE and IEEE Computer Society, Lebanese Order of Engineers, Saudi Association for Health Informatics and Australian Computer Society. He is an editorial member of the journal of engineering and technology research and the journal of health informatics in developing countries.