

Content Management System for ECD Education in Bandwidth Constrained Communities: A Literature Review

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1 Abstract

Content Management Systems (CMS) are software systems that host, organise, and distribute content on behalf of an organisation or company. This content can range from text based, to images and video. Content Management Systems are important because they allow programmers to give users the ability to upload, manage, and view content without the need for advanced technical skills. CMS can be utilised specifically by NGOs in order to fulfill their obligations to the communities they serve. NGOs are of specific interest because content distribution via digital platforms can be used to facilitate the education and training of users across varying age groups in areas of interest such as maternal health and early childhood development. Content Management Systems that draw content from different parts of the internet may need to explore unique architectures such as service mashups that allow different content to be integrated into one, succinct, final product. Content Management Systems can also be used to host content that shows up on external systems and devices - this will require an in depth understanding of APIs and how to utilise them. The paper's objective is to provide a comprehensive exploration of the latest techniques, evaluation methods, and design trends in the creation of Content Management Systems . By highlighting the potential for improving the use of Content Management Systems specifically by NGOs working in bandwidth constrained communities, the paper aims to better facilitate research at the intersection of CMS and NGOs by exploring opportunities to make CMS more generalisable and easily deploy-able for NGOs working in bandwidth constrained communities.

2 Introduction

You and Your Baby is a project that focuses on code-signing an early childhood development (ECD) content delivery system with communities and NGOs. The aim of the platform is to provide custom, curated content to parents in bandwidth constrained communities. The platform that has been deployed currently consists of three components: a web portal that can be accessed by members of staff at NGOs that work in the ECD space, a web app that can be accessed by clients, and an android application that works by pulling content

off of the website using APIs.

The project is currently deployed in the communities of Ocean View, and Sweet Waters South Africa with planned expansions in Limpopo and Gauteng. This deployment has not come without issues. Due to fundamental architectural issues in the design of the mobile application, deployment is difficult when a new iteration of the application needs to be released. This often results in large sections of the codebase needing to be rewritten before each new deployment which is an inefficient and costly exercise. Additionally, the web portal and web client are both hosted on WordPress websites. This has proved convenient in the past but because the application is constantly growing, changing, and requiring new deployments, it is no longer feasible to use WordPress because it does not provide the portability required for iterative deployments. This project will consist of 3 major practical components: redesigning the mobile application to make deployments in different regions easier, moving the website's functionality off of WordPress, and designing APIs that cater to the newly designed system and newly designed website. This literature review explores areas of research regarding Content Management Systems, Community Networks and NGOs, and APIs and Service Mashups.

3 Content Management Systems

Web content management systems (CMS) are software applications that should allow users to create, edit, publish, and store digital content. There are many recorded uses of content management systems including those with social media, education, or healthcare applications. The overall concept of a CMS does not only include the architecture of the software of the system but also a discussion of how content is created, moderated, stored, and presented to users. Many open source CMS exist and many employ the use of interesting methods in order to manage how users are presented with information.

3.1 Content Management Systems

As the internet grows larger, and as more organisations deal with the requirements of having a growing presence on the internet, it becomes more important for all organisations to employ some system of content management [1]. Content management systems facilitate

how a website creates, uploads, stores, and presents content to users. McKeever proposed a four layered approach to the understanding of the CMS. These layers are the content layer, the activity layer, the outlet layer, and the audience layer[1]. The content layer describes the type and format of content that the organisation will be using[1]. The activity layer describes any high level activities associated with the content[1]. The outlet layer describes the outlets on which the content can be accessed whether this be the internet, intranet, or extranet[1]. Finally the audience layer describes the different groups of users who will be presented with the content and how best to provide them with that content[1]. Additionally, McKeever describes a content management life cycle of a CMS which includes within it the processes of content collection, content delivery, workflow, and, control and administration[1]. The CMS performs the specific function of improving the efficiency and effectiveness of internet delivery. At its core, a CMS should provide functionality for versioning, workflow, and integration of different types of content [2]. Integration stipulates that content should be stored separately from the design of the website and should be integrated with the website during the later stages[2]. Workflow refers to the need for content to be appropriately assessed and reviewed before being presented to users[2]. A good CMS must have features that support user management - deciding what content to show to which users, user interface design, data sources - the appropriate use of DBMS, application support, and good deployment practices[2].

3.2 Existing CMS

Three CMS: Joomla, Drupal, and Wordpress are reported to make up 70% of all web traffic to CMS [3]. Wordpress is reported to host 29% of all websites[4]. Joomla is an open source, free to use CMS designed for the purpose of making highly interactive multi-language websites that support a range of functions from blogs to e-commerce sites[3]. Drupal is a similar CMS that is designed specifically to be used by users with little to no technical knowledge [3]. Drupal allows users to dynamically add advanced features as their website grows and need arises[3]. Wordpress, which is perhaps the most famous of all open source CMS, is characterised by its unique community of plugin contributors[3]. Wordpress allows people to build and sell plugins that can be used on any Wordpress site [4]. These plugins allow site creators to expand the functionality of the site beyond the features provided to them by the base Wordpress program[4]. The large community of plug-in creators has contributed to the success of Wordpress by allowing large amounts of customisability within the platform as well as the abstraction of functions that would ordinarily require lots of technical domain knowledge to execute into simply executable plugins.

3.3 Evaluation of CMS

Many different types of website and application can technically be categorised as content management systems. There needs to exist a paradigm for evaluating the success of a CMS in achieving its aims. A content management system used for the proliferation of educational material can be evaluated using 5 criteria. These are system quality, information quality, user satisfaction, intention to use, and net benefits[5]. Information quality was found to play the greatest role in self regulated learning for CMS in learning environments [5]. The DeLone & McLean Information Systems Success Model can be used as a model to evaluate the success of an information system across disciplines[6]. This model evaluates a system based on System quality, Information quality, Service quality, Use, User satisfaction, and Net benefits[6]. System quality refers to the characteristic of the system such as usability, availability, reliability, and response time[6]. Information quality describes the relevance and completeness of the content used on the system[6]. Service quality describes the support given to the system by the service provider[6]. Use requires that usage data from visitors to the system be recorded and analysed[6]. User satisfaction measures the opinions and experience of people using the system to receive content[6]. Finally, the net benefit of the system describes any overall positive or negative impact that the CMS has on its users or domain[6].

3.4 Content

Interesting considerations must be made for the ways in which content is delivered to users on CMS. There has been a move in recent years to automate and personalise CMS through the use of algorithms so that users are automatically shown content that is most relevant to them and their context. One way of doing this is to assign and recommend content to users based on their geographic location [7]. An exploration of a database of YouTube videos found a high correlation between related videos and the geographic location of both the video creator and the video watcher[7]. Researchers found that the retrieval of videos was faster because of a high correlation between content locality and geographic locality in User Generated Content [7]. Personalised content retrieval can also be achieved using ontological knowledge[8]. This ontology based personalisation framework works by creating ontologies using very specific language consisting of words and trends extracted from the content a user has already accessed [8]. The creation of these ontologies can be matched with ontologies created by analysing other forms of content and if there is a match, this new content can be presented to the user as a suggestion [8]. This improves the content retrieval process by taking into account the specific interests of the users[8].

4 Community Networks & NGOs

Community owned networks are just one facet of ICT For Development (ICT4D) that are being implemented locally in order to improve the lives of people on the ground. They focus specifically on the need for low-bandwidth internet connections in a modern, internet-driven world. Developments like these go hand in hand with the rise of technology use in the NGO world. Technology is used by NGOs both to remedy the shortcomings of governments and to make the jobs of those NGOs easier and more efficient.

4.1 ICT4D Electrification and Network Projects

ICT4D projects often fail for a number of reasons. Most prominent among these is a lack of government support with upkeep and maintenance [9]. A sustainable solution to this problem is to directly involve community members in electrification and network based projects [9]. This involves up-skilling community members so that they can install and maintain technologies in their communities without the need for intervention from external parties[9]. It was found that after installation, social connections were the most important factor encouraging the use of new technologies[9]. Community members are required to encourage one another to use new technologies by outlining the benefits and ease of use of those technologies. Once widely in use, new network and electrification technologies have the ability to support economic development through the creation and growth of new business, as well as improve gender equity in communities by empowering women to be involved in entrepreneurial activities[9]. In another instance, an exploration was done to introduce Telehealth technology to rural communities with the specific aim of exploring the role that bandwidth constraints had in ICT4D. The report found that it is necessary for technologies built for rural communities to be low-bandwidth applications [10]. This involves the use of methods such as store-and-forward, which stores information locally and only connects to servers when internet is readily available[10]. This is especially pertinent for any technology that aims to transfer video and image files to and from communities as these are the most expensive types of data [10]. Community owned networks are a viable solution to issues of bandwidth constraint in communities [11]. Community owned networks build localised internet infrastructure in under-served areas with the goal of making the internet and services more accessible [11]. INethi is one such network operating in South Africa that aims to do this by hosting web services and other local community services on local infrastructure [11]. Inquiries into the Internet usage of these community members found that the majority of content used on the servers was coming from Europe and The United States[11]. This is not ideal as data from these regions is stored further away from the network and is more bandwidth intensive to access[11]. The proposed solution is to encourage com-

munity members to access information and resources produced locally[11]. This is content that is sourced from within the African continent or even from within that specific community. Although local services and content are available, more work needs to be done to alert community members of its existence and availability on local networks [11].

4.2 NGOs and Technology

NGOs or non governmental organisations exist across the globe to remedy some of the issues that governments are not capable of attending to due to mismanagement, and a lack of resources, or humanitarian crisis and natural disaster. Technology has become increasingly central to the operation and functioning of an NGO[12]. Because many issues that NGOs wish to address sit outside the realm of a government's capabilities, NGOs rely on the use of technology to support their operations. Many NGOs use technology and their position to empower communities through education and the dissemination of knowledge[12]. This puts NGOs in an interesting moral position as they hold significant amounts of power over the people they serve who do not yet have access to the information the NGO wishes to proliferate[12]. Assuming these moral issues are addressed, one must acknowledge the ways in which technology benefits NGOs. Technology allows NGOs to significantly lower operational costs as well as improve efficiency [13]. Technology such as programs, applications, and websites allow NGOs to streamline and automate much of their administrative, and information processing tasks[13]. Additionally, NGOs that use technology such as websites and applications for the purposes of disseminating knowledge can rely more on technology and less on human staff to achieve their aims[13]. Many NGOs use websites and social media to improve their reach, increase participation, look for donors, and help their target audience gain access to vital information[13]. In light of all the benefits and harms associated with the introduction of technology into NGO run spaces, one group of researchers has proposed 'action research' as a paradigm with which to facilitate the use of technology in NGO activities [14]. Action research proposes four unique steps for introducing technology into the operation of an NGO. first the creation of a community inquiry[14]. This involves meetings, workshops, and interviews with members of the NGO and the community they hope to help to establish a list of requirements, needs, and boundaries associated with the use of new technologies. Next the creation of a set of 'theories in practice'[14]. These are a set of interrelated theories of action for dealing with problems typical for practical situations. Third the theories can be tested and analysed through the introduction of the technology in the community[14]. Finally, the creation of alternatives, which involves cycling through the entire process and iteratively producing better versions of the product that address issues and are a better fit for the community in question[14].

5 APIs and Mashups

This section of the review deals with the study of Application Program Interfaces (APIs) and Service Mashups, and how they can be used to create websites and applications in ways that are efficient and modular. At its simplest, an API is a way for two or more computer programs to communicate with one another. APIs are very important in the context of You and Your Baby because the mobile application relies on APIs to pull information off of the website to display it to the client.

5.1 API Design

The key to writing good APIs is first and foremost to write good modular code as modular code informs the capable use of APIs[15].An inquiry performed on multiple well established API designers reported that the best practice in building APIs is to put oneself in the proverbial shoes of the API user. This was often achieved by creating use cases [15] or personas for the API user to assess the kinds of data that would need to be fed into the API and what kinds of information would need to be returned [16]. Through interviews with participants many interesting insights about APIs were gleaned. Among these are the fact that APIs are prone to breakages after software deployment which can cause problems and bottlenecks for software systems dependent on the APIs for functionality [16]. This makes the case for the consistent maintenance of APIs after deployment. There are steps that can be taken before deployment to mitigate the risks of API breakages, however. Among these is the avoidance of factory creation patterns and mandatory constructors in the design of an API [16]. The paper puts forward the idea that the main reason for the design of bad APIs is a lack of Human Centred Design practice in the development of the API [16]. API design should directly involve the users of the API and should involve continuous consultation and collaboration with these people to avoid APIs being created for the wrong use cases [16]. Additionally, bad API documentation makes it difficult for new users of the API to understand and utilise the API. Good APIs should not require extensive documentation as they should easily be understood by their context, name, and list of required parameters [15] although documentation remains necessary.

5.2 Service Mashups

A service mashup is a web application that combines multiple sources of data from existing websites to create more powerful, collaborative web applications [17]. Service mashups have become increasingly popular on the web because they allow developers to use services that have already been developed, tested, and deployed to create their products. These services can be provided by large companies such as Google and Flickr or from other smaller websites. Service mashups work by integrating APIs that pull information from different parts of the web, RESTful architectures, and scripting

languages to create new products [17]. These new websites have their interfaces dynamically updated on the client-side to provide an interactive experience for users that integrates the different services so that they behave in a unified manner and interact with one another in a way that is natural and effective on the side of the user [17]. Service mashups are a relatively new way of creating web content and so they do come with some limitations that need to be addressed. First among these is the issue of semantic heterogeneity [17]. Semantic heterogeneity refers to when different web services inconsistently define and communicate data [17]. This means that developers of service mashups may struggle to integrate and consolidate data that comes from services that have different conventions for the definition and naming of data. Service mashups are also hindered by the need for APIs that do not yet exist [17]. Developers who create service mashups may want to access information from a part of the web that does not have an API available to produce the required output. Alternatively, any APIs that do exist may be difficult or insufficient to use and may return data in a format that is cumbersome or undesirable. The paper motivates for the creation of Domain Specific Languages (DSLs) that will unify the structure of mashups and make it easier for developers to manage service mashups that draw on a variety of sources [17]. Another team of researchers have created a platform that seeks to introduce a principled approach to the architecture of mashups where previously mashups were a collection of disjointed point solutions to common problems. A good , functional mashup consists of views, data models, and interaction controllers. The platform creates these mashups by following three integral steps. First data mediation occurs [18]. This is the process whereby data from different feeds and APIs is converted and transformed into the native formats of the website that will be deployed. Second, process mediation choreographs different APIs to create new processes that can be presented to the user as single points of interaction [18]. Finally, user interface customisation occurs to elicit information input from the user and use this information to facilitate the display of information to the user [18]. The developers of the platform found that those wishing to deploy a website consisting of a mashup of services saved a considerable amount of time by using the platform to design and code their website. The platform remains to be tested on a wider variety of use cases with increasing degrees of customisation.

6 Discussion

The concepts outlined above go deeper than simply understanding the necessity and functionality of a Content Management System. Together they provide a holistic review of the process of designing Content Management Systems for NGOs and people who are constrained by bandwidth. Provided in this review is a description of Content Management Systems and the

methods necessary to evaluate them. It is important to have a framework for building content management systems that focuses not only on the architecture of the software system, but also a holistic view of the kinds of content, how that content will be managed, and how that content will be distributed. With regards to the software system, an architecture similar to a service mashup is likely to be the best option when creating a content management system that draws content from various online sources. This is important as it will allow the architecture of the system to be flexible enough to incorporate new types of content from different sources as the need arises. The You and Your Baby mobile application will work by pulling content off of the website that You and Your Baby is hosted on. This will require the efficient use of APIs to allow the easy and efficient transfer of content between the two software entities. All of this must be managed in the context of NGOs that are hoping to provide early childhood development content to bandwidth constrained communities. A possible method of curtailing bandwidth constraints is to make the entire You and Your Baby system available from within the iNethi Network. This would significantly reduce the associated bandwidth costs as content could be hosted on the local servers and accessed directly by people in the community. Additionally, users should have the ability to download content assigned to them or content that they want to see onto their mobile device from the iNethi server or the internet for later use. There is an opportunity here to focus on the type of content that will be created as part of the CMS cycle. If content is being hosted locally, then local content can also be created to support interest of community members. This may be achieved by actions as simple as varying the languages that content is available in depending on the geographic region of the servers. This research can be taken further by exploring what the ideal functionality and feature scope would be for any NGO to create a custom learning-based content management system that can be customised and loaded with content before deployment with little technical knowledge. This would allow for more customised and localised iterations of You and Your Baby and for different NGOs to create similar offering quickly and easily.

7 Conclusions

A number of important conclusions can be drawn from this review. First and foremost, any Content Management System must be designed holistically with the community it is being designed for in mind. This means that at every layer of the CMS, bandwidth constraints and the needs of the users must be taken into account. Additionally, community owned networks are a good vehicle by which NGOs and other actors can make content easily accessible to members of the public through the use of Content Management Systems. There must be a focus on community ownership of aspects of the content and the network architecture to endure that

participation is encouraged by the community. The use of good APIs and Service Mashup architecture is fundamental to the success of a Content Management System that is responsible for distributing content across devices and domains in a manner that is efficient and easy to replicate. A well designed Content Management System will allow the You and Your Baby project to be a useful and easily deployable software system that will make ECD content accessible to parents in bandwidth constrained communities.

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