

Short-term adoption rates for a web-based portal within the intranet of a hospital information system

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ABSTRACT

Objective An intranet portal that combines cost-free, open-source software technology with easy set-up features can be beneficial for daily hospital processes. We describe the short-term adoption rates of a costless content management system (CMS) in the intranet of a tertiary Greek hospital.

Design Dashboard statistics of our CMS platform were the implementation assessment of our system.

Results In a period of 10 months of running the software, the results indicate the employees overcame 'Resistance to Change' status. The average growth rate of end users who exploit the portal services is calculated as 2.73 every 3.3 months.

Conclusion We found our intranet web-based portal to be acceptable and helpful so far. Exploitation of an open-source CMS within the hospital intranet can influence healthcare management and the employees' way of working as well.

INTRODUCTION

Free open-source software (FOSS) and innovative principles still drive academic, industrial and healthcare software engineering.¹⁻³ Prior studies reveal that the increased maintenance costs of modern hospital information systems (HIS) lead information technology (IT) and biomedical personnel to adopt open-source technologies for developing applications that limit commercial software as solutions for extensions inside the HIS intranet.^{4,5} In addition, resistance to change as a force against change of working mode in enterprises and organisations has been thoroughly studied.^{6,7} Embrace of new technologies by healthcare personnel is a major concern in the behavioural status of healthcare professionals that partly contributes to the refusal to use technology. A healthcare environment consists of a diverse population of end users, with multiple levels of computer skills. From an IT viewpoint, software development is a unique opportunity for integration of many different processes and systems throughout the healthcare organisation.

The following were the objectives of our project:

- ▶ Objective 1: to implement an intranet hospital website based on content management system (CMS) advantages.
- ▶ Objective 2: to control mandatory external links to Greek internet websites for e-prescription using specific eGovernment network configurations (<http://www.syzefxis.gov.gr/-Hellenic; 'SYZEFXIS' Network>).
- ▶ Objective 3: to link custom applications to the intranet portal.
- ▶ Objective 4: to install and exploit a FOSS email communication system plugin via the portal.
- ▶ Objective 5: to evaluate resistance to change behaviour of hospital employees related to technology progress.

DESIGN

We implemented our intranet portal in the 251 General Hospital of Hellenic Air Force, which is a large tertiary hospital (<https://www.haf.gr/structure/gea-2/251gna/>, last accessed December 2018) employing 1850 workers. All parts of the software development followed the Waterfall Model.⁸ Literature review was conducted for advisory work and key points that concerned our methodology.⁹⁻¹¹ Requirement analysis identified the entities (hospital internal key stakeholders) that interact with intranet portal. Table 1 shows that the maximum number of portal users was estimated at 856 (this is almost half of the total number of employees). System architecture was based on the existing internal hospital network and operates on web application logic. CentOS as a Unix/Linux OS distribution and LAMP package (<https://www.apachefriends.org/index.html>, last accessed October 2018) was installed in a virtual machine. Figure 1 shows the general system architecture.



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Table 1 Hospital key stakeholders and estimated number of users of the CMS

Key stakeholders (personnel interviewed, n)	Total estimated number of users	Reasons for using our CMS
Leadership (9)	9	► Access custom application (only for leadership) through CMS web page.
Medical directors (24)	166 (directors, curators and residents)	► Access the national e-prescription web page through a CMS custom link. ► Upload medical tutorials.
Nurse supervisors (24)	480 (registered nurse staff and nurse assistants)	► Inform nurses of their shift rotation schedules. ► Upload information about nursing service.
Chiefs of administration assistance (10)	65	► Upload general hospital information.
Chiefs of logistics and financial departments (2)	73 (logistics and financial officers)	► Upload logistics and financial information. ► Linked Enterprise Resource Planning (ERP)–Customer Relationship Management (CRM) application through CMS web page.
Technical service supervisors (5)	55 (technical service officers)	► Upload technical service progress. ► Receive tickets from employees for technical support (exploitation of a CMS plugin for help-desk ticketing system).
IT centre (Department of Software Exploitation and help-desk staff) (8)	8	► Upload general information for the hospital. ► Receive tickets from employees for IT support (exploitation of a CMS plugin for help-desk ticketing system). ► Review doctors' e-prescription network traffic.

Maximum estimated number of users who benefit: 856.

CMS, content management system; CRM, Customer Relationship Management; ERP, Enterprise Resource Planning; IT, information technology.

In the software development process, we chose WordPress as the appropriate solution of CMS.^{12–14} Software development and implementation time was 3 months. A process of presentations and training was then established to make all users feel comfortable with the new software. At this stage, we trained for a period of 2 weeks (2 hours per day) all the estimated users (according to the internal

hospital key stakeholders) in ways that they can use the CMS portal to speed up and facilitate part of their daily work. The portal was designed to be accessed via an open-source browser from the hospital intranet workstations. All estimated end users have their own workstation.

RESULTS

After 10 months of running the portal, the results are quite encouraging.

Objective 1: The friendly user interface (UI) portal enabled each hospital department to explore their related applications and post and upload their department information (ie, news, documents, tutorials) in a centralised manner.

Objective 2: The portal administrators (personnel of the hospital IT centre) are able to monitor users' log files activities, especially physicians' e-prescriptions. At this point, it should be mentioned that the e-prescription is not the compulsory way of prescribing for all categories of health-insured persons in Greece. Forcing the doctors to use the official Greek Ministry of Health e-prescription website through a web page link from our CMS portal seems to be an effective way of checking medical prescription and pharmaceutical expenses of our hospital.

Objective 3: Information provided through custom applications leads to better exploitation of HIS modules. For example, structured query language (SQL) queries of

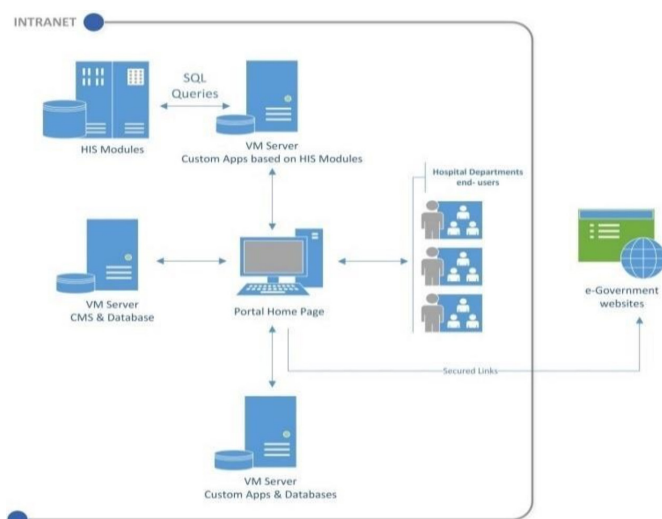


Figure 1 System architecture. CMS, content management system; HIS, hospital information systems; VM, virtual machine.

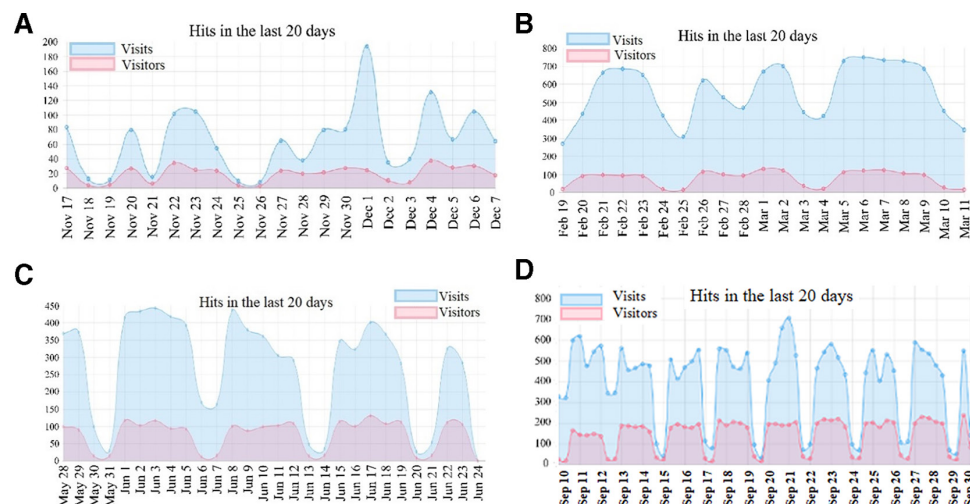


Figure 2 Dashboard hit statistics waveforms between November 2017 and June 2018. November 2017 was set as the test month of software exploitation. (A) After 2 months of operation (February 2018), uniformity is observed in both of the waveforms (visitors and visits). The hollow parts indicate weekends (B). After 10 months of the software release (September 2018), the portal traffic remains stable. There is still uniformity in the hit waveforms (C–D).

HIS database can be executed and displayed as web forms via portal links and widgets, thereby giving the hospital leadership the ability to monitor the real-time hospitalisation of patients.

Objective 4: Installing an open-source email system plugin in the intranet portal allowed establishing a paperless document management process in the hospital. Until an e-document management system is developed, our free open-source email plugin will be the only intranet possibility for paperless communication within hospital.

Objective 5: Dashboard administration hit statistics in the first 2 months of the software implementation (November and December 2017) indicated a traffic jitter (figure 2A). Personal user verbal reports confirmed their resistance to change and their misuse of software. Since February 2018, there has been a steady trend in the waveform of the CMS traffic (figure 2B–D). Table 2 shows that the average growth rate of end users who employ the portal services is calculated as 2.73 times every 3.3 months (or 99 days).

Table 2 Hit statistics

Hits between November 2017 and October 2018

Total visits*

90,370

Average number of users per day

November 2017–January 2018

22

February 2018–June 2018

77

June 2018–September 2018

150

Average growth rate of visitors × 2.73 every 99 days

Each session of the same internet protocol address per day counts for a 'visit' to the web-based portal.

*A visitor (end user) can navigate into the portal many times per day.

Administration panel indicates that each end user visits the portal site on average six to seven times a day. The average number of end users up until September 2018 amounted to 150 per day. However, we think this is not yet the expected outcome. Based on the services provided by the portal, statistics are expected to increase, possibly reaching the estimated number of 856 end users. In addition, the continuous IT support (help-desk service) has helped us increase the observed number of end users.

CONCLUSIONS

In conclusion, it is obvious that empowering modern daily healthcare management with new software implementation is more than a necessity. We believe that the abilities of FOSS can positively influence the daily hospital management to a greater extent. By using free open-source CMS like WordPress for daily hospital management, many paper-based procedures have been computerised. Our intranet CMS provides multiple services, and we aim it to become the central starting point for computer-based tasks of the hospital employees. A future study using a satisfaction questionnaire will demonstrate the effectiveness of our software from another statistical perspective. Similarly, a further research in a measurable analysis of active users regarding the portal services will certainly be concluded.

Eventually, we found our intranet portal to be acceptable and helpful. The average number of employees who exploit the portal services is not yet to the extent desired because all the estimated end users have not exploited our software so far. However, our intranet portal represents an effort to use open-source IT technologies within the hospital intranet to improve the entire HIS framework, but it mostly represents an effort to engage hospital employees in innovative computer-based working mode.

From a healthcare management viewpoint, the CMS-based portal has streamlined the decision for cost-free software adoption in our hospital. In addition, to the best of our knowledge, there is still not enough literature reviewing the contribution of internal networks and applications to healthcare environments.¹⁵ Especially in a period of economic rationalisation for Greece, there is a greater need to save resources at every level.

Finally, we believe that our short report will help healthcare informaticians who are planning intranet portals in their own health units.

Competing interests None declared.

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REFERENCES

1. Ebert C. Guest editor's introduction: how open source tools can benefit industry. *IEEE Softw* 2009;26:50–1.
2. Bagayoko C-O, Dufour J-C, Chaacho S, *et al*. Open source challenges for hospital information system (His) in developing countries: a pilot project in Mali. *BMC Med Inform Decis Mak* 2010;10.
3. Al-Mudimigh AS, Ullah Z, Alsubaie TA. A framework for portal implementation: a case for Saudi organizations. *Int J Inf Manage* 2011;31:38–43.
4. Spinellis D, Giannikas V. Organizational adoption of open source software. *J Syst Softw* 2012;85:666–82.
5. Eshleman RM, Yang H, Levine B. Structuring unstructured clinical narratives in OpenMRS with medical concept extraction. IEEE International Conference on bioinformatics and biomedicine, 2015. Available: <https://ieeexplore.ieee.org/document/7359782>
6. Vrhovec SLR. Responding to stakeholders' resistance to change in software projects—A literature review. 39th International Convention on Information and Communication Technology, 2016. Available: <https://ieeexplore.ieee.org/document/7522314>
7. Smith T, Grant G, Ramirez A. Investigating the influence of psychological ownership and resistance on usage intention among physicians. 47th Hawaii International Conference on system sciences, 2014. Available: <https://ieeexplore.ieee.org/document/6758952>
8. Brambilla M, Cabot J, Wimmer M. Model-driven software engineering in practice: second edition. Morgan and Claypool eBooks, 2017. Available: <https://ieeexplore.ieee.org/document/7899157>
9. Budida DAM, Mangrulkar RS. Design and implementation of smart healthcare system using IoT. International Conference on innovations in information, embedded and communication systems (ICIIECS), 2017. Available: <https://ieeexplore.ieee.org/document/8275903>
10. Gupta S, Mishra A, Chawla M. Analysis and recommendation of common fault and failure in software development systems. International Conference on signal processing, communication, power and embedded system (scopes), 2016. Available: <https://ieeexplore.ieee.org/document/7955739>
11. Schnipper JL, Gandhi TK, Wald JS, *et al*. Design and implementation of a web-based patient portal linked to an electronic health record designed to improve medication safety: the patient gateway medications module. *Inform Prim Care* 2008;16:147–55.
12. Mirdha A, Jain A, Shah K. Comparative analysis of open source content management systems. IEEE International Conference on computational intelligence and computing research (ICIC), 2014. Available: <https://ieeexplore.ieee.org/document/7238337>
13. Krouska A, Troussas C, Virvou M. Comparing LMS and CMS platforms supporting social e-learning in higher education. 8th International Conference on Information, Intelligence, Systems & Applications (IISA), 2017. Available: <https://ieeexplore.ieee.org/document/8316408>
14. Cabot J. WordPress: a content management system to Democratize publishing. *IEEE Softw* 2018;35:89–92.
15. Höst M, Oručević-Alagić A. A systematic review of research on open source software in commercial software product development. *Inf Softw Technol* 2011;53:616–24.