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Cloud Based Electronic Health Record Applications are Essential to Expeditionary Patient Care

Edgardo Donovan*

Expeditionary Medical IM/IT, Office of the Command Surgeon, Air Combat Command, US Air Force, 402 Helms Avenue, Suite 100, Joint Base Langley-Eustis VA 23665, USA

Abstract

The Air Force often uses paper to document expeditionary medical records because its IT systems are not properly integrated. To solve this, the Air Force Medical Service (AFMS) and DoD must successfully migrate to a joint cloud based electronic health record (EHR) system. It must be centralized, always up, and easily accessed through a tablet or a smartphone. 83% of healthcare organizations are using cloud based applications today. The AFMS and DoD healthcare will not remain a high reliability organization unless cloud migration is successful. A successful cloud migration will enable all treatment to be electronically documented jointly and available across multiple echelons in the expeditionary continuum of care. If successful, the DoD will deliver the world's first globally integrated cloud based expeditionary healthcare system. Qualitative and quantitative analysis in this research concludes that cloud migrations must properly address IT security and cloud privacy concerns. The DoD must reach out to software vendors to help them integrate security standards cheaply during product design. Success here will allow the use of innovative application development platforms such as Amazon Cloud as well as Commercial-Off-the-Shelf (COTS) software and telehealth applications.

Keywords: Air force medical service; Cloud migration; Amazon cloud

Current State of Air Force Expeditionary Healthcare Information Technology

Col David Johnson (ACC/SGX) explained at the 2013 Global Medical Readiness Symposium, "Expeditionary Medical Support (EMEDS) is a rapidly deployable, tailored medical response supporting the full range of medical operations [1]. It is a modular buildup and is light, lean, and life-saving [2,3]." It is about providing the right level of care on time and on target. The EMEDS deployable force modules are the EMEDS Health Response Team (HRT), EMEDS+10, EMEDS+25, and the Air Force Theater Hospital (AFTH). All four have different compositions, populations at risk, care levels, full operating capability timelines, and footprints. The first three EMEDS deployable force modules are illustrated in Figure 1. EMEDS provides flexibility for the AFMS to execute its mission in any area of responsibility (AOR). Additionally, lessons learned from humanitarian assistance and disaster relief operations have decreased EMEDS setup times and improved initial and full operational timelines. An EMEDS unit can be collectively protected meaning medical operations can continue after certain chemical, biological, radiological, or nuclear (CBRN) incidents [4]. EMEDS IT requirements are determined by ACC/SG, ACC/A6, Theater Medical Information Program (TMIP) Program Management Office, and the Integrated Logistics Support Manager (AFMOA/SGALW). All equipment must be compliant with deployed force information system naming conventions and information assurance requirements [5]. EMEDS does not deploy with data infrastructure and relies upon expeditionary combat support and base operating support due to its limited organic support capability. EMEDS relies on the host base's communication unit for support and its data communication infrastructure. Additionally, EMEDS facilities rely upon network control centers for basic core network functions such as network administration, management, and information assurance. Figure 2 displays a notional EMEDS network configuration per the Air Force Tactics, Techniques, and Procedures 3-42.71 [6] where the red arrow connects the laptop server to the base communication unit.

Strength of EMEDS is its network configuration that can be easily scaled-up as the AFMS uses the modular buildup from an EMEDS HRT to EMEDS+25 capabilities. The network configuration expands as the AFMS transitions from an EMEDS HRT to a larger EMEDS by adding more laptops and printers to emergency medicine, medical ward, dental clinic, critical care, primary care, and preventive medicine. An EMEDS+10 and EMEDS+25 have a server suite compared to a laptop server in an EMEDS HRT configuration. The ability to expand the network provides flexibility as the mission requirements change. However, EMEDS has a limited organic capability and relies on base operating support for data infrastructure and a connection to the Internet. The medical systems UTC (FFSYS) consists of one Medical Service Corps (MSC) officer and two health service managers (4A). The three personnel are part of the 58-bed AFTH. Prior to the AFTH buildup, the MSC or 4A with the most systems expertise will be tasked to act as the facilitator between EMEDS and base support and execute the necessary actions so the EMEDS network functions properly.

A weakness of EMEDS computer and radio IT equipment is they run off a local area network under a client/server topology making medical data sharing across the DoD continuum of care very challenging. Consequently, as patients are moved out of the AOR to medical treatment facilities (MTF), paper medical records are almost always used as the chief medical information sharing mechanism.

***Corresponding author:** Major Edgardo Donovan, Chief, Expeditionary Medical IM/IT, Office of the Command Surgeon, Air Combat Command, US Air Force, 402 Helms Avenue, Suite 100, Joint Base Langley-Eustis VA 23665, USA, Tel: 17577640160; E-mail: edgardo.donovan@us.af.mil

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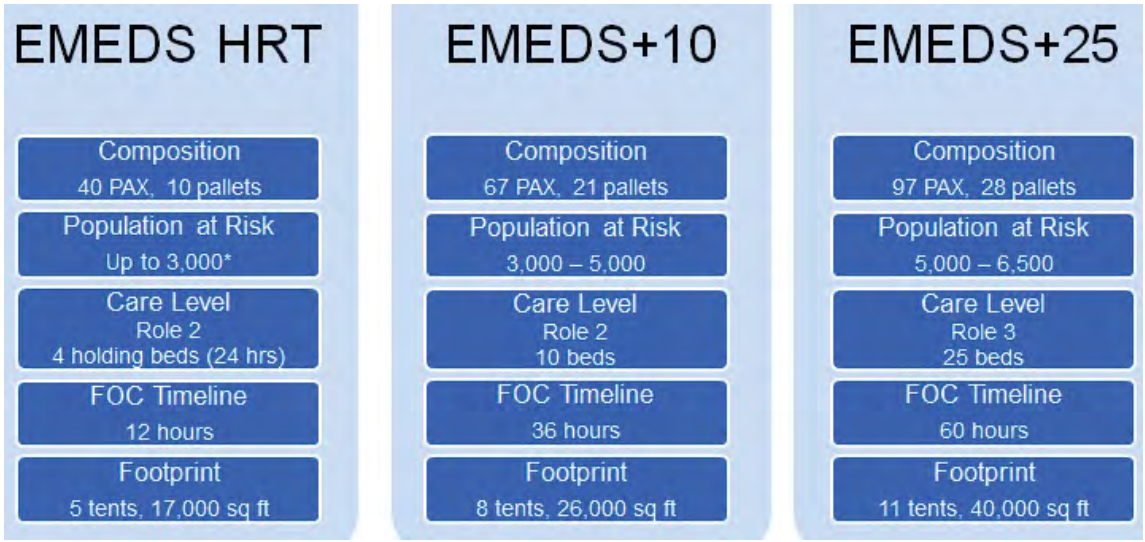

Figure 1: EMEDS deployable force modules.

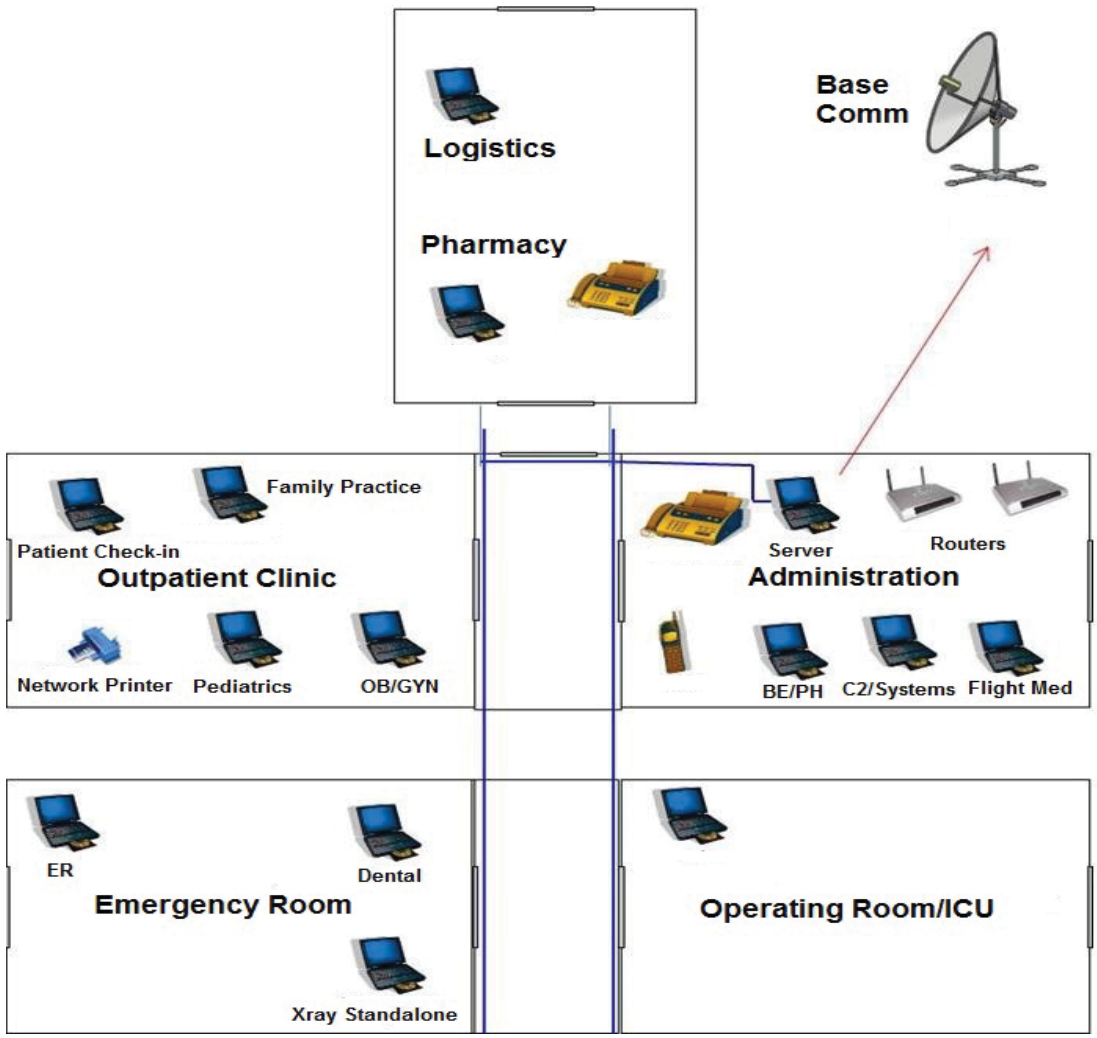

Figure 2: EMEDS HRT network configuration.

This is far from ideal as paper records can be lost in transit creating significant patient safety issue as well as the need for re-diagnosis.

Cloud Computing: A New Paradigm

Cloud computing is ideal for healthcare delivery through an EHR especially for a global organization like the Air Force that often operates in austere anti-access (A2) and area denial (AD) environments in foreign countries. Cloud computing is a type of internet-based computing platform that provides shared computer processing resources and data to computers and other devices on demand [7]. It is a model for enabling ubiquitous, on-demand access to a shared pool of configurable computing resources (e.g., computer networks, servers, storage, applications and services), which can be rapidly provisioned and released with minimal management effort [8]. Cloud computing is the provision, utilization, and management of internet-hosted software applications, data storage, and computing services for their computing needs rather than applications on their local computers. Cloud computing is most certainly a new paradigm for accessing networked resources irrespective of location via the internet [9].

During the past 10 years, internet bandwidth has increased considerably. People interact not only with personal computers, but through tablets and smartphones. Even though it is faster to store and access a file or an application on a personal device or a local network, in some cases it is practical to do the same via a file or application server at a location far away. As the bandwidth constraints of storing files and accessing applications through external sources connected to the internet have diminished, many individuals and companies have begun eschewing the use of their PC and local area networks. The use of the cloud to access information, utilize applications, and interact online has increased. Most instances of cloud computing today are though web browsers (i.e., Chrome, Explorer, Safari, etc.) or through quickly downloadable applications that can be utilized easily not only from a tablet or PC, but through a smartphone as well.

Cloud computing offers three distinct advantages over traditional pc/network server computing: free-flow of information [10], flexibility of IT infrastructure [11], and better system quality [12] in terms of better accessibility of pertinent information. In essence cloud systems are better and cheaper than client server networks. Cloud systems are easily upgraded, enable productivity anywhere, provide off-site data storage, do not require on-site IT maintenance, are ideal for information recovery during disasters, have a high reliability rate, and cost less to own as shown in Figure 3.

The cloud's free-flow of information takes place at an increasingly rapid and intuitive manner between people online thanks to the advent of sophisticated algorithms. Intelligent application design leveraging smart algorithmic functions through the cloud has transformed the internet into an intelligent personal assistant in many areas of life. Some algorithms not only help you find or accomplish what you need know, but predict your information needs and suggest solutions accordingly. During the past ten years companies like Google, Amazon, and Facebook have embedded algorithmic design into their computer applications enabling a more customized and intuitive web experience. Google has become the leading search engine in the world due to its ability to track web activity, build customized profiles, and deliver customized information through push and pull mechanisms. Facebook is the leading social media company and utilizes algorithms to suggest friends and determine the type of content that is most pertinent to its users.

The cloud's flexibility of infrastructure denotes how easy it is for a person or organization to integrate the information residing on personal computers with the greater cloud infrastructure. Years ago, integrating information between different systems required a customized networking integration, software integration/redesign, or at the very least data export/imports from one system to another. Cloud applications do not have significant integration challenges impeding the free-flow of information. They are designed to run off the web browser platforms which are already designed to work with over 95% of personal computers, tablets, and smartphones. Additionally,

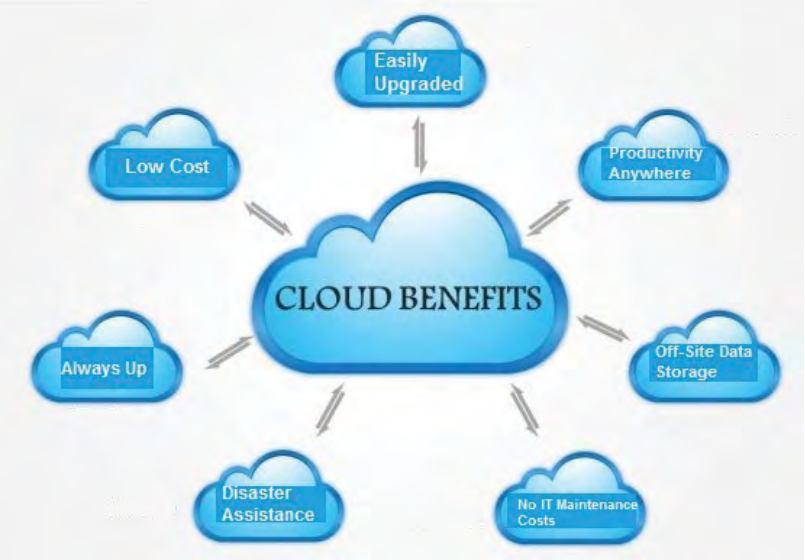

Figure 3: Cloud computing benefits.

users can download and install applications running on Apple, Google, or Microsoft platforms that will constantly update themselves 24 hours a day. Ultimately, all this leads to much higher system quality satisfying an ever growing number of user's needs.

Why Migrating to the Cloud is Essential for High Reliability Organizations (HRO)

As the AFMS recently transitioned to the HRO model, successfully migrating to cloud computing is as important as ever. As an HRO, successful cloud migration will lead to organizational success as IT will deliver an organizational competitive advantage through the secure integrated global sharing of medical information cheaply.

The Medical Group Management Association, which also functions as a Baldridge Excellence Performance Board Examiner, states that there is a big problem in the healthcare industry with siloed and fragmented data spread across many EHR systems that do not integrate well together. With the goal of becoming a HRO, healthcare organizations should be motivated to improve patient care and control costs by investing in a cloud-based analytics platform to integrate data from all EHRs within existing information technology infrastructure. Embracing HRO Promotes Performance Excellence in the healthcare delivery [13].

Gartner, Inc., the world's leading information technology research and advisory company, says that more than $1 trillion in IT spending will be directly or indirectly affected by the shift to the cloud during the next five years [14]. This will make cloud computing one of the most disruptive forces of IT spending since the early days of the digital age. As the cloud computing phenomenon continues to grow, a new understanding measuring the relationship between the variables that drive the adoption of cloud computing against those that hamper it is needed.

The Air Force needs to understand the factors affecting successful implementation of cloud computing to have a better sense on how to calibrate their migration to the cloud without taking unnecessary security [15] and privacy risks [16]. Despite the high number of approved cloud projects, companies have a hard time completing them because of security and privacy concerns. Not properly assessing the right balance of privacy and security settings will foster cloud migration failure and the continued reliance on costly upkeep of expensive and obsolete legacy IT infrastructure. Throughout the US private-sector healthcare system, there are numerous examples of successful healthcare delivery through cloud based systems.

Cloud Computing Success in Private-Sector Healthcare

US private-sector healthcare is a large and growing industry that is experiencing a major transformation in its information technology base through the increased use of cloud based health informatics. Information systems confronted similar transformations in other industries and developed theories and methods that proved useful in healthcare applications. In turn, information systems may benefit from incorporating knowledge from health informatics, a discipline that studies IT within medical services delivery, management and planning contexts [17].

A successful migration to the cloud is essential for a healthcare HRO because of the shift towards health informatics. The Health Insurance Portability and Accountability Act of 1996 (HIPAA), similar laws, and regulations are motivating the development of standardized healthcare systems with an increase of attention towards private and secure data. Financial motivations, organizational acquisitions, and mergers are prompting healthcare administrators to implement large-scale IT integration projects.

The uses of cloud based application are pervasive in private-sector medical organization. 83% of healthcare organizations are using cloud based apps today whereas 92% of healthcare providers now and in the future see the value of cloud services for their organizations. 43% currently use the cloud to host clinical applications and data. 37% of IT healthcare organizations chose to deploy their cloud applications on private cloud architecture. 36.3% choose a hybrid cloud model and 23.4% chose public clouds.

New technologies are forging ways to enhance value and lower telehealth operations costs also. For example, ImageZone is a cloud-based medical image sharing platform designed to provide a digital alternative to the traditional methods of sharing radiology images on hard copy films and CDs. The platform allows healthcare providers to securely access and share patient medical images, such as X-rays, mammograms, MRIs, ultrasounds and CT scans, in real time. Relieved of the burden of managing hardware, storage, and maintenance, IT departments that use cloud computing are able to focus solely on applications and servicing their end-users. Therefore, IT staffing burdens are reduced and certain IT staff can be reallocated to other areas.

If the EHR is cloud-based, it can be accessed from a computer at other geographic locations. For example, in the midst of catastrophic events, many healthcare providers are able to continue vital patient care and keep essential communication using the EHR cloud. Surprisingly, during a hurricane, physicians could still use the EHR cloud for billing, transmitting prescriptions, checking patient medication lists, and consulting with the patient about all their medical conditions. The experience of New York University Langone Medical Center, which had to evacuate 300 patients during the height of Hurricane Sandy due to power outages, shed light on the lifesaving benefits of the EHR cloud. The cloud EHR is not only a lifesaving tool during a disastrous storm; it can also enhance a physician's ability to care for patients as a vital long-term tool [18]. The shift of information technology activity to the cloud has caused a dramatic change to organizational processes around the globe. The Air Force must utilize this innovative technology.

Cloud Computing Benefits for Expeditionary Medical Care

There is an incredible opportunity for the DoD to provide quick, integrated, and safe patient care for its expeditionary service members by creating the world's first large-scale globally integrated cloud based expeditionary healthcare system depicted in Figure 4 on the next page [19]. Due to its reliance on a traditional client server functional model, currently the Air Force is very rudimentary in leveraging network technology in a deployed setting. Although there is some IT at deployed locations it is not properly integrated with the rest of its service let alone the full spectrum of DoD healthcare.

Medics require access to the full scope of network medical applications throughout the continuum of care with a laptop, tablet, or handheld device anywhere in the world to include austere locations. This would allow combat medics who come into contact with a patient

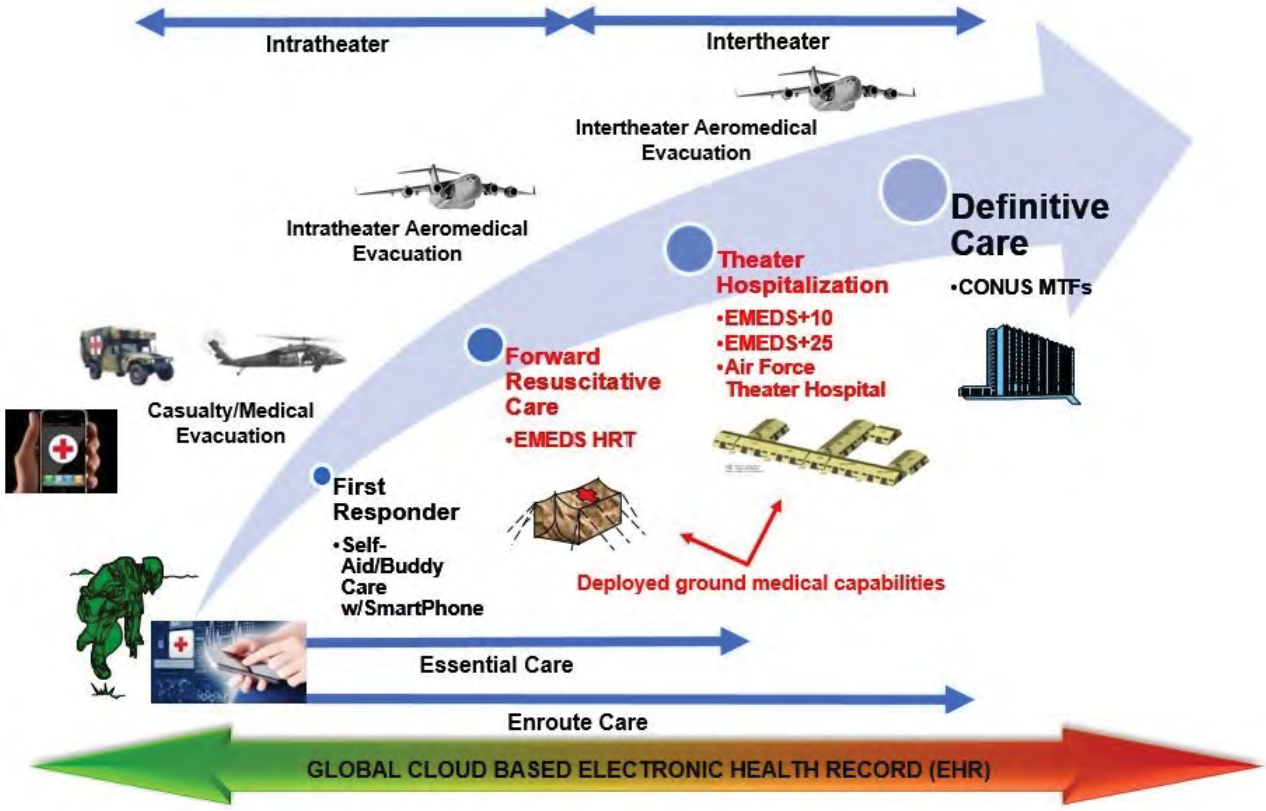

Figure 4: World's first large-scale globally integrated cloud based expeditionary healthcare system.

to retrieve their EHR via DoD ID or social security number and update it accordingly prior to referring them to the next appropriate echelon of care across the DoD. The only way this is possible is through the use of a ubiquitous, always up, and EHR medical cloud system rather than the traditional network client/server systems we currently use.

Cloud Computing Migration Literature Review

What are some of the impediments impacting the Air Force's slow migration to the cloud? Are there theories and models from Academia that can be utilized to measure factors affecting Air Force cloud migration success? To answer these questions a scholarly literature review of cloud computing adoption is required.

There has been a plethora of research concerning cloud computing adoption but so far there has been no attempt to update Delone and McLean's information systems success theory to reflect the great changes brought about by cloud computing [20]. Alhammadi et al. [21] researched factors that influence cloud computing adoption using Diffusion of Innovations (DOI) and the Technology-Organization-Environment (TOE) theories. Security had a statistically significant relationship with cloud adoption. Top management support, organizational readiness, and enterprise status significantly influenced cloud computing adoption. Oliveira et al. [22] used a Diffusion of Innovations (DOI) and Technology-Organization-Environment (TOE) theories to measure innovation characteristics effects on the adoption of cloud computing. They surveyed executives from 369 Portuguese firms in the manufacturing and service industries. Their quantitative findings suggest that complexity, technological readiness, top management support, and firm size influence a firm's adoption of cloud computing. Bhattacherjee and Park [23] researched the behavioral intentions in switching to cloud computing in their application of migration theory. They found that intention to migrate to the cloud had a positive effect (standardized β=0.578; P<0.000) on cloud migration. Hsu et al. [6] utilized Technology-Organization-Environment (TOE) theory when examining cloud computing implementation. They surveyed 200 Taiwanese firms consisting of Taiwan's information and communications technology (ICT) manufacturing, ICT service, general service, and general manufacturing industries. They found that perceived benefits and IT capability are positively related to cloud computing adoption while business concern is negatively related. Obeidat and Turgay [24] formulated and validated the Technology Trade Theory (Triple T) in their analysis of factors affecting cloud adoption initiatives. They incorporated Social Exchange Theory into the Technology Acceptance Model. They found a positive relationship between the advantages of cloud computing and behavioral intentions. Cegielski et al. [9] used Organizational Information Processing Theory to measure how information processing requirements and capabilities affect the intention to implement supply chain cloud computing technology. Low et al. [25] used the Technology-Organizational-Environment (TOE) Framework to investigate factors that affected the implementation of cloud computing by high-tech firms [25]. Park and Ryoo used the Two-Factor Theory of Technology Usage to investigate factors which moderated end-user adoption of cloud services. They found that switching benefits had a significantly positive effect on intention to switch (standardized β=0.179; P<0.01) and switching costs

had a significantly negative effect on intention to switch (standardized β=-0.128; P<0.01). Finally, Behrend et al. [3] utilized the Technology Acceptance Model (TAM) in their investigation of factors leading to successful adoption of cloud computing in a community college setting. The Unified Theory of Acceptance and Use of Technology (UTUAT) measure the financial, usability, and psychological factors that influence the propensity to use a system [26].

In conclusion, Information Systems Success theory is one of the most widely cited models to measure systems adoption and should include cloud computing. It can be adapted to measure the positive factors that influence people to use the cloud (free flow of information, flexibility of IT infrastructure, and system quality) as well as the negative factors that constrain the use of the cloud (i.e., security and privacy concerns).

Privacy/Security Risks of Cloud Computing

A quantitative study based on the preceding literature review found that cloud privacy concerns and IT security concerns are significant challenges negatively affecting an organization's intention to use the cloud and overall satisfaction with cloud based systems. A new conceptual cloud adoption model depicted in Figure 5 was created.

Invitations to complete a 23-question online survey (Appendix A) were sent to all Air Force Medical Service Corps (MSC) officers' specialty matched to IT or serving as a Chief Information Officer within the AFMS and eleven responses were returned. Overall, R squared regression analysis (Appendix B) showed that IT security and cloud privacy concerns are holding back the speed of cloud computing adoption. Free flow of information (moderate 0.6, strong 0.76), flexibility of IT infrastructure (strong 0.76, moderate 53), and system quality (strong 0.79, strong 0.84) had moderate/strong positive correlations with intention to use/user satisfaction respectively. IT security concerns (-0.008, -0.6) and cloud privacy concerns (0.09, -0.56) had negative correlations to intention to use/user satisfaction respectively. Intention to use (0.44) and user satisfaction (0.6) measured moderate positive correlations with net benefits.

Risk Management Framework (RMF) Obstacle for US Software Industry

Based on the data from the preceding quantitative study, cloud privacy and IT security concerns are the most significant obstacles for DoD cloud computing adoption. The above quantitative data shows a negative correlation between privacy/security concerns and cloud adoption. The DoD needs to successfully address user privacy and security concerns for a successful transition to the cloud.

The DoD emphasizes cybersecurity over software usability and cloud migration. Prior to allowing a software program to operate on its network, the DoD must vet it through an intense IT security accreditation process known as the RMF which was formerly known as the DOD Information Assurance Certification and Accreditation Process (DIACAP) referenced in Figure 6. Cybersecurity related policies and issuances are numerous and always changing, which makes the overall compliance process very challenging [27]. Cybersecurity assessments to include vulnerability assessments, intrusion assessment, cyber-security inspections, and adversarial test operations are integrated into the entire DoD software deployment lifecycle which includes design, testing, evaluation, and maintenance. These processes are reflected in the Test and Evaluation Master Plan (TEMP) and coordinated with the DoD Test Resource Management Center Currently the DoD RMF process is much more stringent than any information assurance program in the private and other public sectors. However, it is not clear whether the complex system regulating is truly warranted. Currently, RMF is regulated by over 200 policies underwritten by over 17 offices of primary responsibility. This complexity constitutes a large challenge for any software vendor that would like to customize its already existing software and develop future applications for the DoD in a timely and

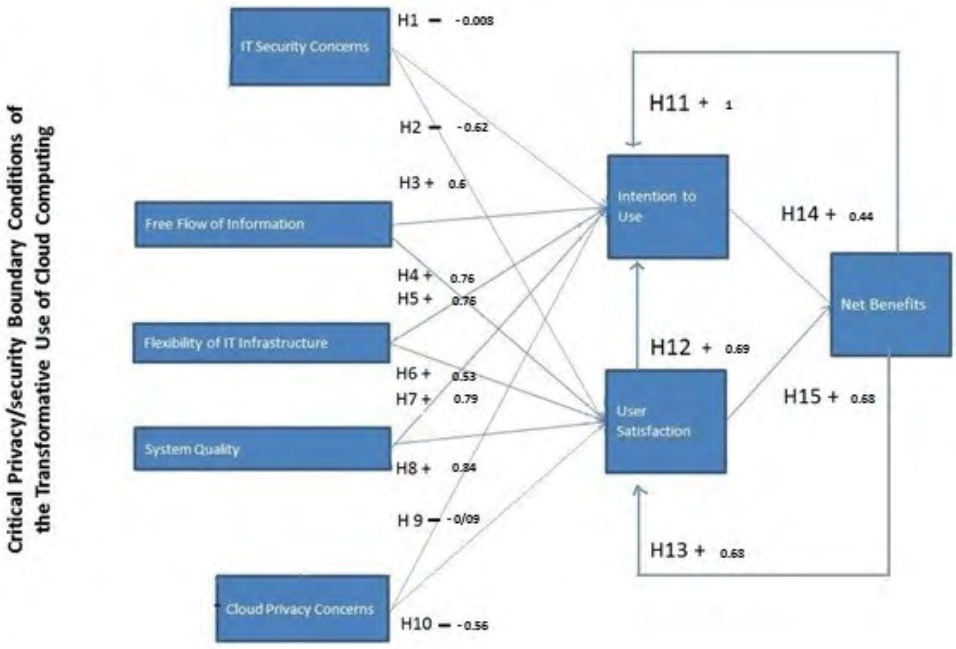

Figure 5: Conceptual research model with quantitative analysis.

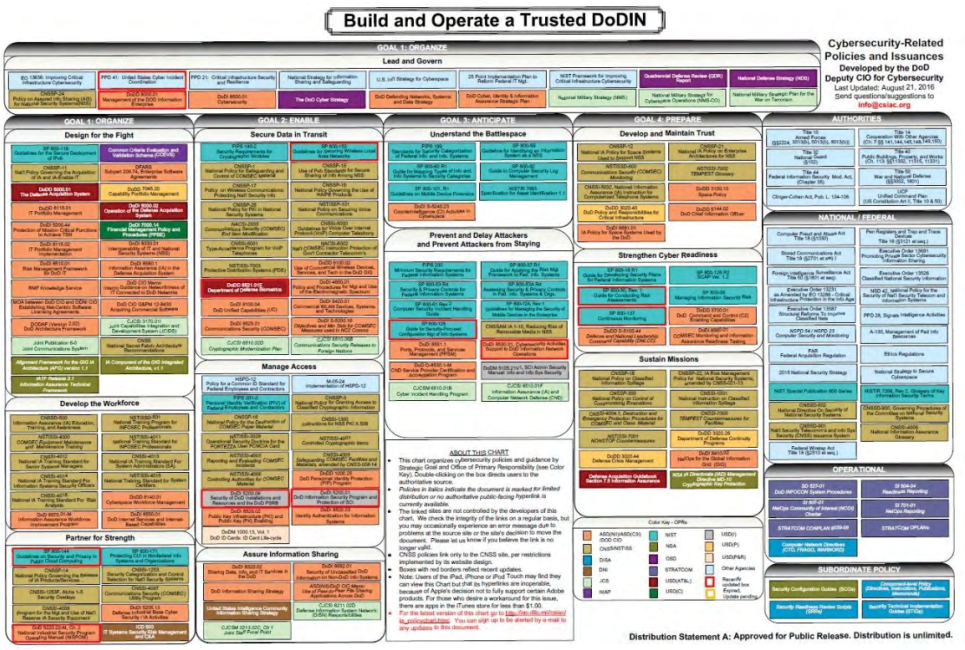

Figure 6: Complex RMF cybersecurity related policy and issuances.

effectively manner. Streamlining the overall process would lead to easier and cheaper cloud computer adoption.

Colonel Richard "Chip" Terry, the AFMS CIO, mentisoned that commercial off-the-shelf private-sector software vendors worry about incorporating Air Force cybersecurity standards after their products have already been developed [28]. Applying patches and other safeguards can often involve costly product re-engineering. As shown in Figure 7 on the next page, the software re-engineering process often equals and sometimes is more expensive than the original development cost [29]. Most vendors start, but ultimately abandon RMF. Clearly, the cost of RMF for vendors is too high. Why double your development costs for the chance of selling in to a single albeit large additional customer such as the DoD?

While the RMF process is essential in protecting the Air Force network from cyberattacks, it constitutes a labyrinth for software vendors developing sophisticated EHR cloud applications. Consequently, the Air Force invests in multi-billion dollar IT custom software/training/support acquisitions. The large acquisitions budget cannibalizes funds for the Air Forces medical IT operations budget reducing overall usability and productivity among its users.

In order to deliver better expeditionary healthcare, the DoD must protect its network while transitioning to the cloud. They can do this by integrating innovative COTS software. The Air Force can deploy cheaper and more sophisticated software if it relied less on proprietary systems and more on COTS software. To do this, money should be taken from the large IT acquisitions budget to grow the currently small IT operations and maintenance budget.

Recommendation 1: Grow IT Operating Budget and Reduce IT Acquisitions Budget

To operate multiple cutting edge cloud based COTS EHR applications the AFMS currently needs to balance out its operating and acquisitions budgets by investing more on operations and less on big ticket IT acquisitions as shown in Figure 8. Surprisingly, the Healthcare IT budget in the Air Force is miniscule resembling that of a medium sized company. The healthcare expeditionary information technology budget is approximately $2.5 million per year for sustainment [30]. Additionally, due to the $20 trillion national debt and past sequestrations, the budget will remain relatively flat in the foreseeable future.

Unlike the operating budget, the healthcare IT (HIT) acquisitions budget is gargantuan. Over the past twenty years the AFMS has relied on custom developed multi-billion dollar proprietary software platforms such as the Composite Health Care System (CHCS) and the Armed Forces Health Longitudinal Technology Application (AHLTA) that have been very expensive to field, maintain, and train users. The AFMS is set to spend $11B over the next nine years to field its latest iteration of the new EHR system called Genesis which is a COTS developed by Cerner Corporation with.

Recommendation 2: Simplify AFMS RMF

The DoD can leverage more expeditionary healthcare applications while developing more nimble and modern IT services by simplifying its cybersecurity RMF within its system acquisition lifecycle. Streamlining primary responsibility offices while reducing redundant regulations would be an important first step in making the DoD software deployment process faster, easier, safe, and more modern. Ultimately, a more predictable deployment process could lead to greater interoperability between DoD RFM stakeholders and prospective DoD software suppliers in designing and testing prototype software applications jointly. Additionally, similarly to what the DoD will do with the MHS Genesis launch, there should be a streamlined process for granting joint DoD authority to operate (ATO) with reciprocity for applications among all Services.

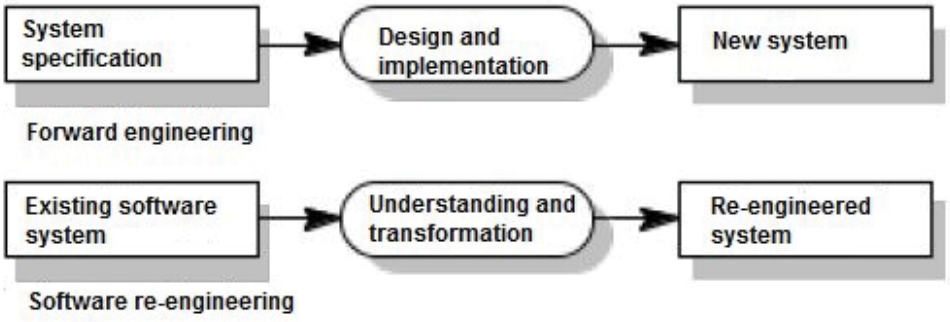

Figure 7: High cost of software re-engineering.

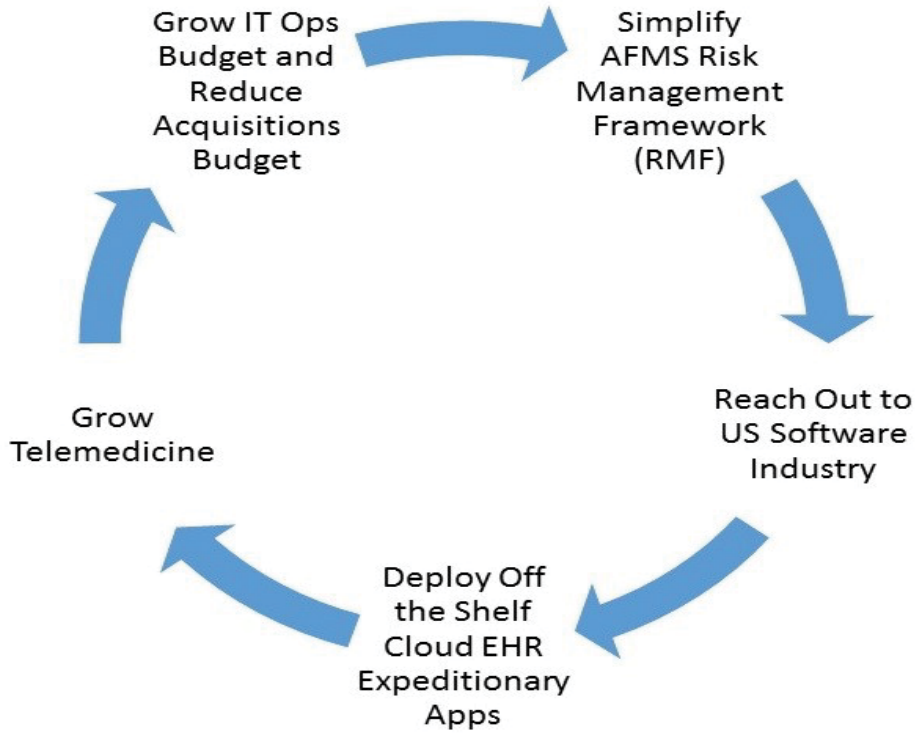

Figure 8: Recommendations.

Great progress has been recently made in RMF simplification. On 8 April 2017, an ATO was granted to Amazon Cloud Services enabling it through bundling to operate an unlimited number of databases and applications on the Air Force network [31]. This will bring down the cost of developing and deploying database driven applications while reducing the amount of time required deploying them.

Recommendation 3: Reach Out to US Software Industry

Through a consortium, the AFMS could influence private sector software developers to incorporate Air Force/DoD cybersecurity standards cheaply at product development inception. The vendor's incentive would be receiving an ATO that would enable them to compete in the $1B DoD Medical IT annual market. The AFMS would transition towards a low-cost medical IT ownership model like its private sector counterparts rather than being a vertical IT integrator developing large, expensive to maintain, and custom built systems based on obsolete technologies. DoDI 5000.02 states, "Cybersecurity RMF steps and activities should be initiated as early as possible and fully integrated into the DoD acquisition process, including requirements management, system engineering, and test and evaluation" [32].

The recent ATO granted to Amazon Cloud Services will allow the DoD to migrate its existing data into Amazon databases and utilize rapidly deployable intuitive applications.

Recommendation 4: Deploy COTS Cloud EHR Expeditionary Applications

The AFMS must continue investing in updating its IT offerings to enable DoD-wide cloud continuum of care delivery interaction through mobile and browser based apps. This will allow medical IT services to move beyond the costly site-specific architecture of the LAN client/server model and offer access to medical IT wherever there is a Wi-Fi connection and a computing device (desktop, laptop, tablet, phone, etc.).

In 2015 the DoD launched MiCare, a cloud web application secure messaging solution, that successfully enabled patients to communicate with their provider teams [33]. Rather than setup an appointment, wait, and come into a MTF, patients are able to get answers to medical questions within one business day online. The application is very popular with provider teams who can take care of their patient population with less appointment. Currently, MiCare is actively used by over 50% of the DoD's patient population [34].

Tricare Online (TOL), the online patient portal that allows patients to schedule appointments with their providers and to view their EHR, has not been as successful as MiCare. In the Air Force, TOL is actively used by only 6% of the patient population. The low utilization has been attributed to a very difficult registration process for non-active-duty patients as well as the system's inability to successfully integrate the totality of electronic health data from CHCS and AHLTA.

In 2017 the DoD started testing MHS Genesis, the electronic health record system designed to replace AHLTA and CHCS. Unfortunately, MHS Genesis is not a cloud EHR system. The system will operate under an expensive client/server model using obsolete technology. It will have authority to operate on all DoD networks. It will have an instant messaging feature that will replace MiCare and a patient electronic health record portal that will replace TOL.

In the absence of a true cloud solution and to improve access to patient data in the short-term, it is imperative that the DoD deploy a MHS Genesis healthcare provider web portal accessible through smart portable devices. This will provide POI combat medics access to MHS Genesis through smartphones or tablets. It will also enhance EHR functionality in austere environments so patients are tracked electronically in real-time as they move throughout the continuum of care. For example, in the midst of catastrophic events, many healthcare providers can provide vital patient care and maintain essential communication by accessing the EHR through a smartphone or tablet. If forced to evacuate from a hostile area, physicians could still use the EHR for writing and transmitting prescriptions, checking patient medication lists, and consulting with the patient about all their medical conditions.

Great progress has been recently made in increasing the capabilities needed to deploy COTS cloud EHR expeditionary applications. The DoD can leverage the databases and applications already created by Amazon to deliver advanced EHR applications. Amazon Cloud Services are not just a product or a service, but a development platform as well. For a yearly subscription fee customers have the ability to develop and deploy their own custom made applications. The DoD has an immense pool of IT talent that it could leverage to develop next generation applications at no additional cost. There are many AFMS medical professionals who are passionate about technology. Some have taught themselves how to program and to develop databases. In recent years, many doctors have become demoralized at the perceived inferior state of DoD medical IT when compared to what is available in the private sector. Leveraging Amazon Cloud services could inspire an unprecedented wave of excitement about medical IT innovation along with higher morale and better retention in the years to come.

Recommendation 5: Grow Telemedicine

Once a successful transition to the cloud is complete, the DoD can significantly lower costs while expanding access to quality healthcare both in-garrison and in expeditionary environments by leveraging telehealth. Telehealth in radiology and mental health has been successfully implemented for many years. The DoD should expand its tele-radiology capability into the cloud utilizing COTS software similar to what is developed by ImageZone. Furthermore, primary and specialty care telehealth is progressing between DoD clinics and hospitals. Figure nine on page 30 is a recent example. In 2016, the Department of Defense's first Joint Service Telehealth Program was implemented bringing 30 specialty capabilities from Landstuhl Regional Medical Center (Army) to the 52 Medical Group clinics at Spangdahlem Air Base (Air Force) [35]. US Army Col. Kirk Waibel, telehealth medical director at Landstuhl, explained that the excitement is not just about a piece of technology, but how the provider is helping their patients. Waibel added that the program has already saved soldiers, beneficiaries and commanders an estimated 2,050 work or school days, $1.34 million in travel-related expenses and reduced 825,000 kilometers in vehicle travel between local clinics and Landstuhl. US Air Force Col. Joe McFall, 52nd FW commander said, "There are two things that are awesome about the project: the tangible and the intangible". The tangible piece is how we talk about innovation: doing it faster, better and cheaper, which this allows us to do all of those things. The intangible piece is there, too, which is how this allows making our Airmen, our families and our community better (Figure 9).

Conclusion

Over the next ten years the AFMS has an incredible opportunity to lower costs and increase the quality of its expeditionary medical information technology services by removing integration barriers while successfully addressing security and privacy concerns as it migrates to the cloud. In doing so, the AFMS will not only remain an HRO but also deliver the world's first globally integrated cloud based expeditionary healthcare system. To be successful, the AFMS must reach out to private sector medical software developers, motivate them to sell into its $2B per year medical software market, integrate simplified cybersecurity

Figure 9: Nurse performs telehealth exam with offsite surgical physician assistant watching on screen.

standards into all stages of off-the-shelf cloud applications design, and deploy next generation telehealth services.

References

1. Columbus L (2014) 83% of Healthcare Organizations are Using Cloud-Based Apps Today. Forbes.
2. David J (2013) Air Combat Command Expeditionary Medical Operations, Global Medical Readiness Symposium, Joint Base Langley-Eustis, VA.
3. Behrend TS, Wiebe EN, London JE, Johnson EC (2011) Cloud Computing Adoption and Usage in Community Colleges. Behav Inform Technol 30: 231-240.
4. Robert LC (2014) Healthcare Information Technology (HIT) in an Anti-Access (A2) and Area Denial (AD) Environment.
5. .Robison III CEJ (2014) Expeditionary Medical Support (Emeds) and Air Force Theater Hospital (AFTH). Air Force Tactics, Techniques, and Procedures 3: 42-71.
6. Hsu P, Ray S, Li-Hsieh Y (2014) Examining Cloud ComputingAdoption Intention, Pricing mechanism and deployment model. Int J Manag 34: 474-488.
7. Qusay H (2011) Demystifying Cloud Computing. The Journal of Defense Software Engineering, pp: 16-21.
8. Peter M, Timothy G (2011) The NIST Definition of Cloud Computing (Technical report). National Institute of Standards and Technology: U.S. Department of Commerce.
9. Cegielski C, Jones-Farmer L, Wu Y, Hazen B (2012) Adoption of Cloud Computing Technologies in Supply Chains: an Organizational Information Processing Theory Approach. International Journal of Logistics Management 23: 1-10.
10. Atuahene-Gima K (2003) The Effects of Centrifugal and Centripetal Forces on Product Development Speed and Quality: How Does Problem Solving Matter. Academy of Management Journal 46: 359-373.
11. Gautam R, Muhanna WA, Barney JB (2005) Information Technology and the Performance of the Customer Service Process: A Resource-based Analysis. MIS Quarterly 29: 625-652.
12. Barbara W, Peter AT (2005) Theoretical Integration of User Satisfaction and Technology Acceptance. Information Systems Research 16: 85-102.
13. https://www.mgma.com/practice-resources/articles/fellow-papers/2016/high-reliability-organization-in-the-healthcare-industry-a-model-for-excellence-innovation-and-sus
14. Viveca V (2016) Worldwide Public Cloud Services Market is forecast to reach $204 billion in 2016. Gartner, United States.
15. Arun R, Brown P, Tang X (2009) Organizational Assimilation of Electronic Procurement Innovations. Journal of Management Information Systems 26: 257-296.
16. Jai-Yeol S, Kim SS (2008) Internet Users' Information Privacy-Protective Responses: A Taxonomy and a Nomological Mode. MIS Quarterly 32: 503-529.
17. Wilson E, Lankton N (2004) Interdisciplinary Research and Publication Opportunities in Information Systems and Healthcare. Communications of the Association for Information Systems 14: 332-343.
18. Wang L, Alexander S (2014) Medical Applications and Healthcare Based on Cloud Computing. Inter Jour Clo Compu Serv Sci 2: 217-225.
19. Robert LC (2017) Operational Medicine IT Update Meeting.
20. DeLone W, McLean E (2003) The DeLone and McLean Model of Information Systems Success: A Ten-Year Update. Jour Manag Infor Syst 19: 9-30.
21. Alhammadi A, Stanier C, Eardley A (2015) The Determinants of Cloud Computing Adoption in Saudi Arabia. Second International Conference on Computer Science & Engineering, USA.
22. Oliveira T, Thomas M, Espadanal M (2014) Assessing the Determinants of Cloud Computing Adoption: an Analysis of the Manufacturing and Services Sectors. Information and Management 51: 497-510.
23. Bhattacherjee A, Park S (2013) Why End-Users Move to the Cloud: A Migration-Theoretic Analysis. Eur Jour Infor Sys 23: 357-372.
24. Obeidat M, Turgay T (2013) Empirical Analysis for the Factors Affecting the Adoption of Cloud Computing Initiatives by Information Technology Executives. Jour Manag Res 5: 154-178.
25. Low C, Chen Y, Wu M (2011) Understanding the Determinants of Cloud Computing Adoption. Industrial Management and Data Systems 111: 1006-1023.
26. Venkatesh V, Davis F (2000) A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies. Management Science 46: 186-204.
27. Department of Defense Manual. Guidebook for Integrating the Cybersecurity Risk Management Framework (RMF) into the System Acquisition Lifecycle, Washington DC Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics.
28. Richard C (2016) HIT Director, Headquarters Air Force.
29. Ryan C (2017) Software Re-Engineering. University of Limerick, USA.
30. Arthur A (2017) Critics Warn of $11 billion Pentagon Health Records Fiasco. Politico, USA.
31. DoD Deputy CIO for Cybersecurity. Cybersecurity-Related Policies and Issuances, Washington DC Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics.
32. James HB (2017) Memorandum for Cloud Service Provider, Defense Information Systems Agency, United States Government Library of Congress.
33. Hymel KM (2015) MiCARE Provides Faster Care. Air Force Medical Service, USA.
34. Edgardo DM (2016) Spangdahlem Air Base Access to Care Update.
35. Rusty F (2016) Inaugural Interservice Telehealth Partnership Launches at Spangdahlem. Spangdahlem Air Base, USA.