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Accelerating Electronic Medical Record Adoption & Innovation with Targeted IT Capabilities

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Abstract: Electronic Medical Record (EMR) adoption can be challenging for many hospitals. To address this challenge - Intel Corporation, HIMSS Analytics USA/Europe and Innovation Value Institute have researched a management approach called Healthcare IT Maturity Model (HIT-MM). This approach better equips a hospital to strategize, implement and run electronic medical record (EMR) and general IT services. It involves the joint tracking of EMR adoption levels and maturity of IT capabilities. This allows a hospital to identify the next step in EMR adoption, together with the necessary IT capabilities to plan, implement and run those EMR services. Results highlight specific IT capabilities are of paramount importance for hospitals to achieve and effectively run higher levels of EMR adoption.

Keywords: Electronic Medical Record; Electronic Health Record; IT Capability; IT Organisational Maturity; Business Value; EHR/EMR; IT Capability Maturity Framework; IT-CMF; EMRAM

1 Healthcare Information Technology (HIT) Challenges

Effective management of patient information is not optional, it is essential - placing strong emphasis on how healthcare systems record, store, access, distribute, and analyse patient information. Holt et al (2007) found that in an examination of over 1,800 surgeries, nearly a quarter were delayed due to missing or incomplete patient information.

In this context, the effective adoption of healthcare information technology (HIT) is associated with improvements in the quality of care (Bates, 2002; Buntin et al, 2011) and reduction in costs (Chaudhry et al., 2006, Koshy, 2005) - albeit sometimes within the context of wider healthcare reforms.

Despite this positive effect, frustration remains regarding how to systematically optimise HIT adoption for improved patient outcomes (Buntin et al, 2011). Commonly cited barriers to HIT adoption include expense of implementation, lack of confidence to run existing patient care and other processes uninterrupted while implementing new systems, lack of technical expertise within the IT organisation, and potential negative reaction to using new systems and processes from doctors and other clinicians (Kolbasuk McGee, 2012).

These cited barriers can be compounded further when one considers the life and death nature of the subject, sensitivity of personal healthcare information, regulatory requirements, and the multidisciplinary and hierarchical nature of healthcare profession (Fichman et al; 2011). The enormous opportunity for HIT adoption to positively impact the quality and cost of providing healthcare is more than matched by the challenges of doing so.

2 Research Question and Research Approach

When pursuing HIT adoption, a hospital cannot have a narrow focus on the technology hardware and software acquisition, a hospital also needs to consider what IT capabilities are needed to ensure improved patience outcomes result from HIT adoption. IT capabilities are a bridge between the hospital's strategy and its operations, defined as

> *...the systematic mobilization (i.e. integrate, reconfigure, gain and release) of IT resources (i.e. tangible and intangible) in support of targeted outcomes.*

The research question is therefore defined as

> *What are the prerequisite IT capabilities a hospital needs to deploy and run HIT services – more specifically electronic medical record (EMR) systems – for improved patient outcomes?*

To investigate this question, Intel Corporation, HIMSS Analytics USA/Europe and Innovation Value Institute contributed to researching an approach called the Healthcare IT Maturity Model (HIT-MM). This approach scores a hospital's level of adoption for electronic medical record (EMR) services; and scores the maturity of their IT capabilities to deliver and run those EMR services. This allows correlation between various IT capabilities and differing adoption levels for EMR services, enabling investigation into

what IT capabilities might contribute to adoption and running of EMR services. Further details of how EMR adoption and IT capability were scored are provided in later sections of this paper.

The research methodology chosen is Design Science Research (DSR) techniques, which involves the design of novel or innovative artefacts and the analysis of the use and/or performance of such artefacts to improve and understand the behaviour of aspects of Information Systems (IS). DSR artefacts can broadly include models, methods, constructs, and instantiations (March & Smit, 2005). Table 1 displays the main artefact contributions of this paper.

Table 1: Design Science Research contributions of this paper

Artefact	**Description**	**Main research contributions**
Constructs	The conceptual vocabulary of a domain	Description of the Healthcare IT Maturity Model (HIT-MM)
Models	A set of propositions or statements expressing relationships between constructs	Exploration of relationships amongst HIT-MM constructs
Methods	A set of steps used to perform a task – 'how to' knowledge	Exploration of the key activities to successfully apply HIT-MM
Instantiations	The operationalization of constructs, models and methods	Application of HIT-MM to 16 hospitals, analysis of results

The objective of this paper is to establish the utility of HIT-MM artefacts using DSR techniques. Hevner et al. (2004) offer guidelines for high-quality design research. Below describes the seven guidelines and how they were achieved within this research:

1. Design as an Artefact: Design science research (DSR) involves a process to create artefact(s) - being any designed object with an embedded solution to an understood research problem (Peffers et al, 2008). Table 1 illustrates the resultant artefacts from this paper's research.
2. Problem Relevance: The objective of design-science research is to develop technology-based solutions to important and relevant business problems (Hevner et al, 2004). A section #1 specifies the domain problem, opportunity and potential.
3. Design Evaluation: The utility, quality, and efficacy of a design artefact must be rigorously demonstrated via well-executed evaluation methods (Hevner et al, 2004). The Healthcare IT Maturity Model (HIT-MM) is evaluated using a combination of descriptive evaluation method (using informed argument and scenarios with information from the knowledge base and the opinions of experts); and then moving to observational evaluation (using multiple case study approach). Artefacts were evaluated in terms of correctness, completeness and utility of the constructed artefacts.
4. Research Contributions: Effective design-science research must provide clear and verifiable contributions in the areas of the design artefact, design foundations, and/or design methodologies (Hevner et al, 2004). This paper describes how the three cycles of design science research (DSR) activities (Hevner, 2007) can be applied to the research domain of HIT. The paper also contributes to defining the acceptance criteria for evaluation of resultant design artifacts by applying past knowledge to building novel design science artefacts for the Rigor Cycle.

5. Research Rigor: DSR relies upon the application of rigorous methods in both the construction and evaluation of the design artefact (Hevner et al, 2004). Section #3 of this paper outlines the Rigor Cycle, applying past knowledge to building novel design science artefacts.
6. Design as a Search Process: The research should be organized as a search for the solution of the problem (Hevner et al, 2004). Section #4 outlines the Design Cycle regarding iterating between building and evaluating the artifacts.
7. Communications of Research: DSR must be presented effectively both to science-oriented as well as practice-oriented audiences (Hevner et al, 2004). The publication of this paper in ISPIM proceedings serves to address both academic and practitioner audiences, given the general cross-sectional appeal of ISPIM audiences.

The remainder of this paper broadly aligns to the cycles of DSR activities defined by Hevner (2007):

1. Problem awareness: Section #1 identifies what the problem is and why it is a problem.
2. Suggestion: Section #2 suggests the solution to the identified problem – i.e. the Healthcare IT Maturity Model (HIT-MM) and research method
3. Development: Section #3 develops the solution (i.e. artefacts).
4. Evaluation: Section #4 tests and validates the artifacts by presenting a multi case study application of these artefacts.
5. Conclusion: Section #5 offers summary and general conclusions.

3 Healthcare IT Maturity Model [HIT-MM] Overview

The HIT-MM involves the combined scoring of EMR services and scoring of IT capabilities. A short overview of each approach is presented in this section, together with an overview of healthcare IT case-studies to illustrate emerging technology adoption.

3.1 Electronic Medical Record (EMR™) Adoption Model™[1]

HIMSS Analytics' Electronic Medical Record (EMR™) Adoption Model™ (EMRAM) provides insights on the level of electronic medical record (EMR) capabilities in acute hospitals, with a focus on technology implementation roadmaps to achieve increased levels of EMR and participation in an electronic health record (EHR). It identifies levels of EMR capabilities ranging from the initial clinical data repository (CDR) environment through to an EMR environment where paper charts are no longer used to deliver patient care and all care processes are supported with electronic documentation. EMRAM is an eight-stage model (Stages 0 to 7) that classifies an institution's level of IT adoption. Stage 7 is a fully digitised, virtually paperless environment with a broad range of interoperability and data exchange capabilities with other organisations - Figure 1.

[1] More information at http://www.himssanalytics.eu/emr.asp - and at http://www.himssanalytics.org/emram/index.aspx

European EMR Adoption Model℠	
STAGE	CUMULATIVE CAPABILITIES
Stage 7	Complete EMR; CCD transactions to share data; Data warehousing feeding outcomes reports, quality assurance, and business intelligence; Data continuity with ED, ambulatory, OP
Stage 6	Physician documentation (interaction with full CDSS (structured templates related to clinical protocols trigger variance & compliance alerts) and Closed loop medication administration.
Stage 5	Full complement of PACS displaces all film-based images.
Stage 4	CPOE in at least one clinical service area and / or for medication (ie. e-Prescribing); may have Clinical Decision Support based on clinical protocols.
Stage 3	Nursing / clinical documentation (flow sheets); may have Clinical Decision Support for error checking during order entry and / or PACS available outside Radiology.
Stage 2	Clinical Data Repository (CDR) / Electronic Patient Record; may have Controlled Medical Vocabulary, Clinical Decision Support (CDS) for rudimentary conflict checking, Document Imaging and health information exchange (HIE) capability.
Stage 1	Ancillaries - Lab, Radiology, Pharmacy - All installed OR processing LIS, RIS, PHIS data output online from external service providers.
Stage 0	All Three Ancillaries (LIS, RIS, PHIS) Not installed OR Not processing Lab, Radiology, Pharmacy data output online from external service providers.

US EMR Adoption Model℠	
STAGE	CUMULATIVE CAPABILITIES
Stage 7	Complete EMR: CCD transactions to share data; Data warehousing; Data continuity with ED, ambulatory, OP
Stage 6	Physician documentation (structured templates) full CDSS (variance & compliance), full R-PACS
Stage 5	Closed loop medication administration
Stage 4	CPOE Clinical Decision Support (clinical protocols)
Stage 3	Nursing/clinical documentation (flow sheets); CDSS (error checking), PACS available outside Radiology
Stage 2	CDR, Controlled Medical Vocabulary, CDS, may have Doucument Imaging, (HIE) capable
Stage 1	Ancillaries - Lab, Radiology, Pharmacy - All installed
Stage 0	All Three Ancillaries Not installed

Figure 1: Overview of European and US EMRAM versions

Research data suggests that hospitals at a high level on the EMRAM model are more likely to demonstrate higher performance on both patient care through clinical measures, and efficient hospital performance [HIMSS Analytics, 2006; 2012].

3.2 IT Capability maturity Framework™ (IT-CMF^{TM})[1]

IT-CMF is an IT management framework to assist decision makers manage information technology (IT) capabilities to deploy and run IT/IS services for more value and innovation. It closes IT capability gaps via a toolset that contains maturity profiling methods and organisational improvement roadmaps – refer to Figure 2.

[1] More information at http://ivi.nuim.ie/it-cmf

Figure 2: IT-CMF provides roadmaps for improving IT capabilities

The origins of IT-CMF can be traced back to research at Intel. Since then, the Innovation Value Institute (IVI - a not-for-profit entity) and its international consortium, drawn from across industry and academia, have built upon Intel's original IT-CMF work, enabling public and private sector organisations across differing industries around the world systemically improve how they manage IT for business value and innovation.

Utilising IT-CMF as part of a continuous IT capability improvement programme is associated with improved IT performance including lower IT costs, and higher business value returns [Curley and Kenneally, 2009, 2011, Curley et al., 2012].

3.3 Combined Application of EMRAM and IT-CMF

The unified application of EMRAM and IT-CMF is designed to reveal dependencies between levels of EMR adoption and underlying IT capabilities. Figure 3 provides an illustrative example of a hospital seeking to move from EMRAM level 2 to level 3. The EMRAM score identifies the current level a hospital is at for EMR adoption, while IT-CMF assists with evaluating IT capabilities necessary to achieve the next level of EMR adoption

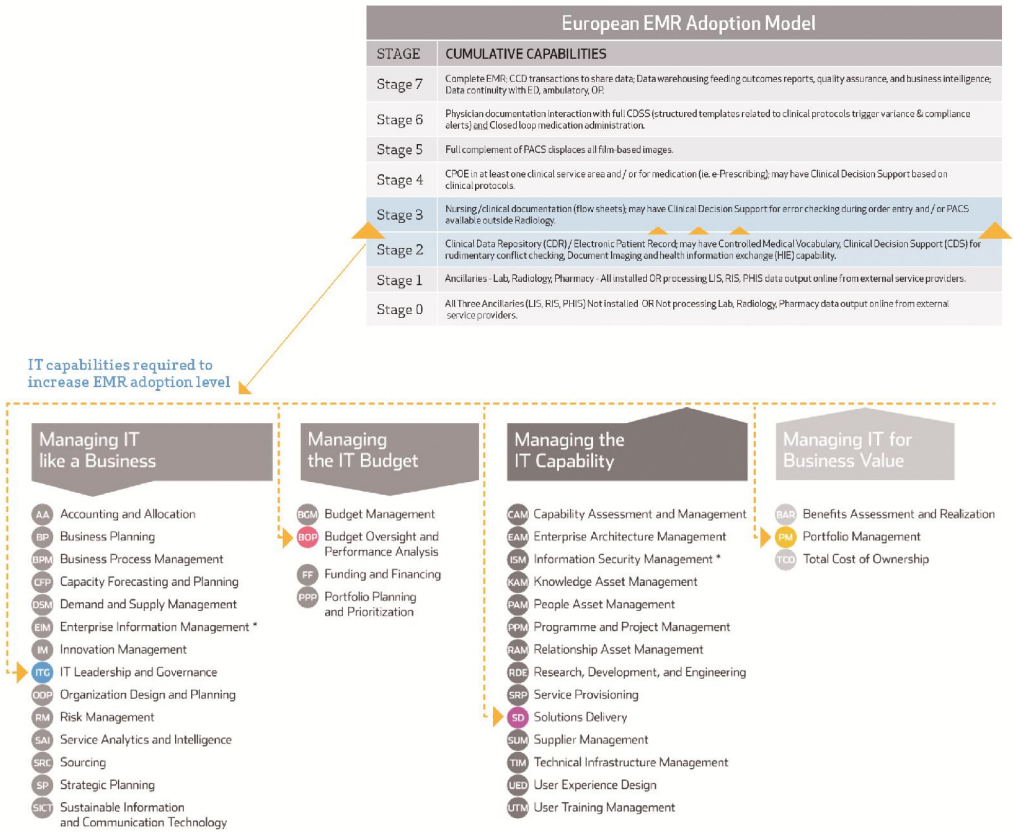

Figure 3: Unified use of EMRAM and IT-CMF – illustrated example.

3.4 Intel Healthcare IT Best-Practice Reference Library[1]

In addition to the unified usage of IT-CMF and EMRAM approaches, Intel Corporation provided healthcare IT adoption proof-points on emerging technologies such as Mobile Health, Security, Cloud and Integrated Care Delivery. This case study library illustrates how hospitals have overcome similar challenges and realised benefits, offering proven adoption strategies for hospitals facing similar challenges.

4 Applying the Healthcare IT Maturity Model [HIT-MM]

The first stage of applying HIT-MM is a workshop (virtual, 2.5 hours) with the CIO/IT-Director plus a selection of IT staff to complete the IT Capability Maturity Framework (IT-CMF) assessment (typically 4-8 participants, however can be more). Participants completed IT capability maturity questions individually online during the webinar, with

[1] More information at http://www.intel.com/healthcare

the facilitator available to assist with clarifications as they arose. Follow-up individual interviews (virtual, 1 hour) for a selected subset of workshop participants were conducted to augment additional insights with the IT-CMF data collected in the webinar.

In parallel, the hospital completed (or updated) their Electronic Medical Record Adoption Model score (virtual, typically 0.5-3 hours for one individual).

In the final stage, analysis of the hospital's IT capability, and actionable improvement roadmaps were presented back to each hospital, based on the analysis of the hospital's IT capability maturity and EMR adoption maturity. Refer to Figure 4 for overview of the process.

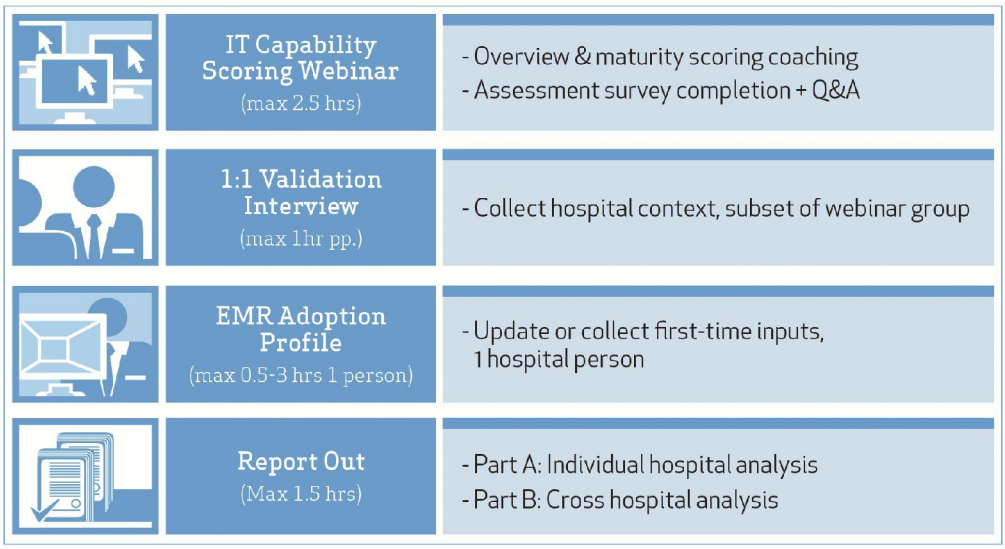

Figure 4: HIT Maturity Model hospital participation process

5 Research Outcomes and Results

The initial phase of this research programme examined sixteen hospitals, covering 15,000+ hospital beds. More than 30% of participating hospitals have 500+ beds and approximately 30% of hospitals have an EMRAM score of 6 or better. For the vast majority, this research programme highlights reasonably strong correlations between hospitals' IT capability maturity (using IT-CMF) with their electronic medical record adoption maturity (using EMRAM). Low EMRAM maturity scores correspond with low maturity scores for the hospital's IT capability to plan-build-run clinical and general IT services. The opposite also applies, hospitals' maturity on IT capabilities tend to be high when their EMR adoption levels are high – refer to Figure 5.

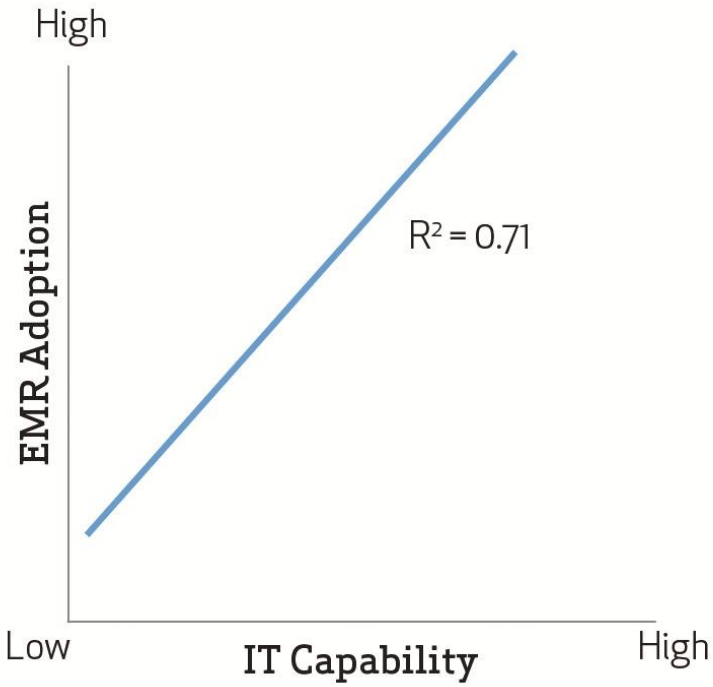

Figure 5: More mature IT capabilities correspond to higher levels of EMR adoption[1]

While an individual IT capability maturity profile for a hospital is typically determined by individual circumstances, recurring patterns are evident between maturity of specific IT capabilities and a hospital's EMRAM maturity scores. For example, as hospitals progress towards higher EMR maturity levels, correspondingly higher maturities in IT Governance and Strategic Planning capabilities are found. Similar relationships are found regarding EMR levels and IT organisational capabilities for Supplier Management, Demand and Supply Management, Enterprise Architecture, and Relationship Management, refer to Figure 6.

[1] R-square can range between 0 and 1, with values closer to 1 indicating greater correlation between variable

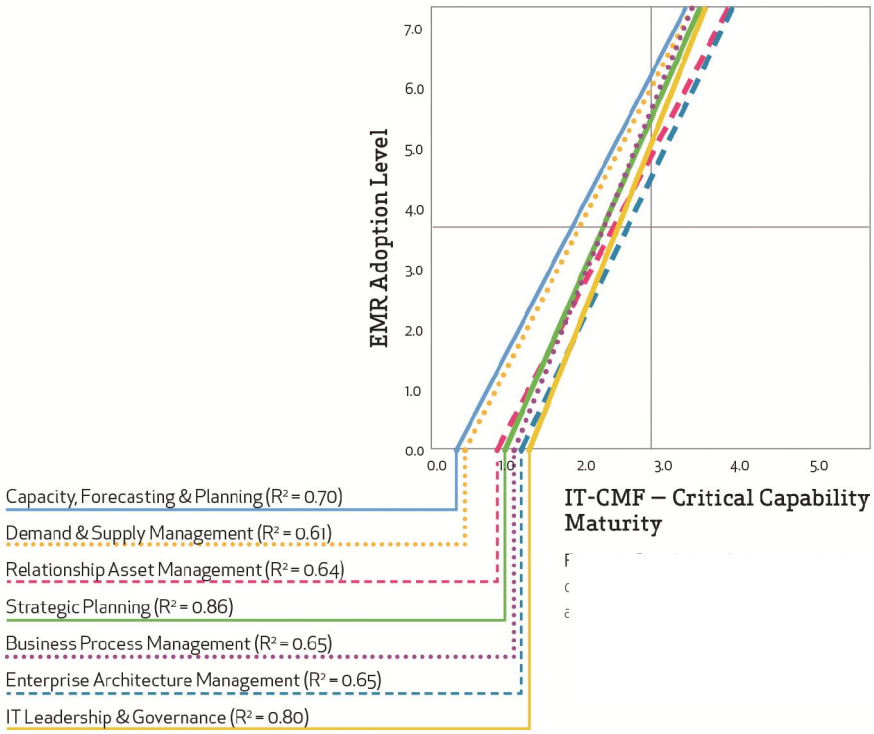

Figure 6: Correlations between maturity of IT capabilities and EMR adoption levels

In addition to understanding which IT organisational capabilities mature in tandem with EMR adoption, it is useful to understand what prioritisation is being attached to specific IT capabilities at different levels of EMR adoption. Perhaps not surprisingly, Strategic Planning has significant importance for hospitals who are achieving higher levels on both EMR adoption and IT capability generally, refer to **Figure 7**. While for hospitals that are lower on both EMR adoption and IT capability maturity, IT Leadership & Governance and Business Process Management are characteristically top priorities. By contrast, hospitals that possess a high EMR adoption but a low IT capability maturity typically prioritise Service Provisioning capabilities – refer to Figure 7.

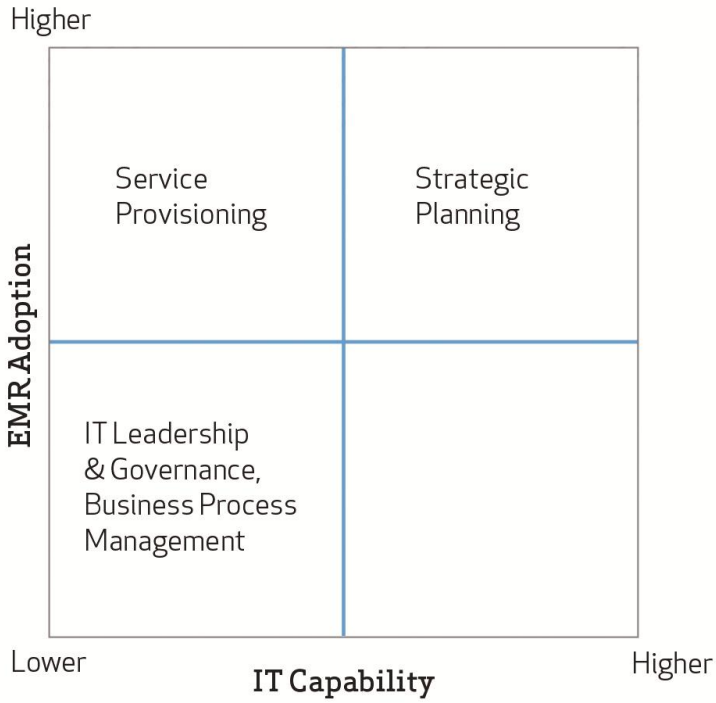

Figure 7: Importance attached to IT capabilities based on EMR adoption and IT capability maturity

Hospitals with combined higher scores on EMR adoption and IT organisational capabilities typically scored better at leveraging emerging technologies in healthcare IT Security, Mobile Healthcare, and Integrated Care Delivery - refer to Figure 8. The Healthcare IT best-practice reference library from Intel Corporation provided follow-on reference case studies for hospitals wishing to explore the potential benefits of emerging healthcare technologies and leverage proven implementation blueprints.

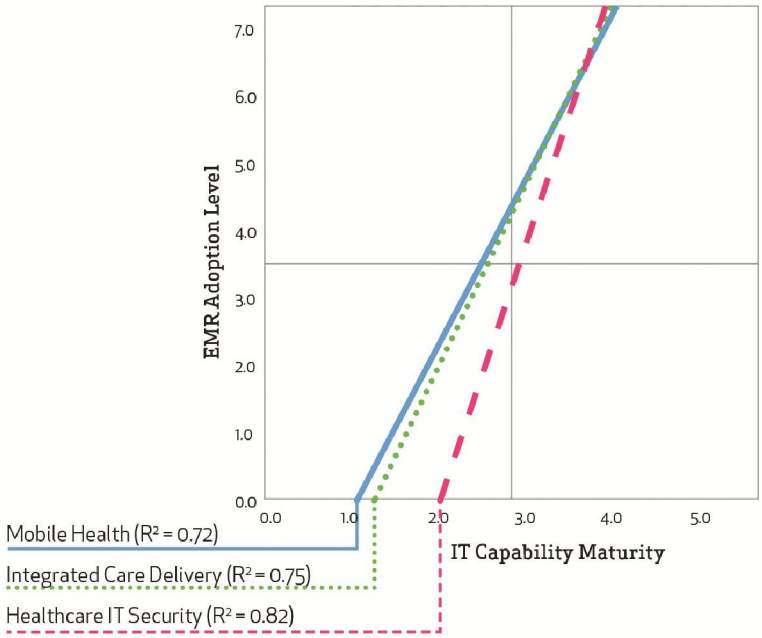

Figure 8: Proficiency to leverage emerging Healthcare technologies based on level of EMR adoption and IT capability maturity[1]

5 Discussions and Conclusions

These trends suggest hospitals with lower EMR adoption scores typically prioritise more technical and IT service orientated IT capabilities. Correspondingly, hospitals at more advanced EMR adoption levels typically broaden their focus to include more 'business' orientated IT capabilities.

Intuitively, this is a reasonable relationship to expect: at lower levels of EMR adoption the IT focus may often be on the implementation and running of discrete (often considered 'back-of-house' or platform) healthcare IT systems. However, to progress to higher EMR adoption levels, the focus extends to management of a wider scope of external stakeholders and organisational change as cross-system integration and point-of-care IT systems become more prevalent in the hospital environment [HIMSS Analytics, 2006; 2012].

Being aware of the requisite IT organisational capabilities can accelerate the achievement of higher levels of EMR adoption, optimising benefits and innovation towards improved patient outcomes. This research demonstrates how the HIT-MM programme can assist a hospital to systematically strategize how to accelerate value impact from HIT systems and services. Under a single umbrella programme, hospitals were able to plan increasing

[1] R-square can range between 0 and 1, with values closer to 1 indicating greater correlation between variables.

their IT capability to plan-build-run clinical and general IT services –the following statements are taken from a sample of participating hospitals.

> *Using this* programme*, we were able to objectively prioritise and systematically enhance IT capabilities by identifying IT organisational capabilities necessary to deliver our Hospital's ehealth imperatives*
>
> John D. Halamka, MD, MS, Chief Information Officer of Beth Israel Deaconess Medical Center, Chairman of the New England Healthcare Exchange Network (NEHEN), Co-Chair of the HIT Standards Committee, Professor at Harvard Medical School, and a practicing Emergency Physician

> *To support healthcare services and be an important part of a hospital's strategy – many IT departments are maturing towards professional and holistic IT service organisations. The Healthcare IT Maturity Model programme is ideal for Hospital CIOs and senior IT decision-makers seeking to enhance their hospital's IT capability and value from IT. Using this programme, we were able to objectively prioritise and systematically enhance IT. The programme can generate a common understanding across the IT department and offer actionable insights on how to address issues to improve business value impact of healthcare IT to the hospital.*
>
> Henning Schneider, Chief Information Officer, University Medical Center Hamburg-Eppendorf (UKE), Hamburg, Germany

Hospital executives should give consideration to understanding which IT capabilities will accelerate innovation in the achievement of EMR adoption, which will lead to improved patient outcomes. The emerging patterns from this research can provide insight; however individual hospital context will often determine the appropriate mix of IT capabilities for a hospital to focus on maturing. A formal evaluation using both EMRAM and IT-CMF is recommended for a hospital to target IT capabilities appropriate to its context.

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