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Abstract:
The introduction and use of cloud computing by an organization has the promise of significant benefits that include reduced costs, improved services, and a pay-per-use model. Organizations that successfully harness these benefits will potentially have a distinct competitive edge, due to their increased agility and flexibility to rapidly respond to an ever changing and complex business environment. However, as cloud technology is a relatively new phenomenon, there is still a lot to learn about the adoption and use of cloud, including issues such as security, data protection, interoperability, service maturity, and return on investment. These issues need to be considered, and if possible remediated, to enable an organization to effectively manage its cloud adoption journey.

This paper describes an assessment model that was developed by the Innovation Value Institute (IVI) using a multi method, two-phased approach. The first phase involved a review of the current academic and practitioner literature in the area of cloud. Based on the key insights identified, together with inputs from a workgroup of industry experts an online cloud adoption assessment instrument was developed. This assessment instrument aimed to provide organizations with a management structure to understand and assess their Enterprise IT capability maturity to evaluate, introduce, and manage cloud services. The second phase employed the principles of design science and open innovation to pilot, test, validate, and refine the cloud adoption assessment in collaboration with industry-based practitioners.

As companies continue to grapple with the issues posed by cloud, the cloud adoption assessment will allow an organization to clearly determine their ability to manage:
- Cloud security
- Compliance
- Data protection
- Cloud service provider(s)
- Costs
- Impact on business and IT
- The interoperability and integration between existing in-house and cloud-based services

By using the assessment model, the level of maturity will identify areas of strength and weakness within the organization and serve as the basis for an improvement roadmap, to ensure the successful adoption and on-going management of cloud.

Keywords: Cloud, drivers, barriers, capability, cloud adoption framework, cloud implementation.

1. Introduction
In the digital business environment, cloud computing has evolved to become a key enabler and a top technology priority for organizations worldwide. According to Computer Weekly (10 Jan 2017) cloud computing tops the list of IT priorities for 2017. However, the adoption of cloud across an organization is a major undertaking, that requires the bringing together of technology, processes, and people to ensure that cloud is successfully implemented and used to deliver value. The introduction and use of cloud promises significant benefits including for example, reduced costs, improved services, improved productivity, a pay-per-use model, and enhanced support for modern methods of working (Doherty, 2015). Organizations who successfully harness these benefits will potentially have a competitive advantage, by increasing their agility and flexibility to rapidly respond to an ever changing and complex business environment.

However, as cloud technology is a relatively new phenomenon, there is still a lot to learn about the adoption and use of cloud including issues such as security, data protection, interoperability, service maturity, and return

on investment. These concerns need to be further examined to see how best an organization can actively manage both the adoption and use of cloud.

A review of the literature illustrates there to be several approaches to cloud migration available, however many serve to provide a high-level structure (Crowe Horwath et al, 2012; Salehi, 2012) as opposed to detailed guidance that can be executed at a practitioner level. In effect, what is missing is an independent holistic management framework that allows an organization to consider all aspects of cloud from a technical, people and process perspective (Lu, 2016).

This paper attempts to address this requirement through the development of a framework at a detailed level to support the migration to and the management of a cloud environment. It describes the Innovation Value Institute's (IVI) cloud adoption assessment, that aims to provide organizations with a management structure to understand their Enterprise IT capability maturity to position, evaluate, introduce, and manage cloud technologies and services. IVI uses a systematic approach to measure an organization's capability maturity that will identify a prioritized list of capabilities and recommended improvements. On conclusion of the assessment the results will indicate the areas of strength and weakness within the organization and be the basis for an improvement roadmap to ensure the successful adoption and on-going management of cloud. The assessment is designed to provide value to individual organizations by enabling them to drive improvements in their adoption and use of cloud, so that they can maximise the potential benefits that cloud can deliver.

The structure of the paper is as follows; section 1 introduces and outlines the need for the development of a Cloud Adoption Assessment; section 2 described the literature review; section 3 outlines the research approach and the methodology used; section 4 describes the cloud adoption assessment and how it can be used as an implementation and management framework; section 5 discusses and provides an overview of the key conclusions.

2. Literature review
2.1. Drivers and barriers to cloud adoption
In recent years, cloud computing adoption rates have proliferated, with the complete spectrum of businesses from large multinationals to smaller organizations migrating their IT services to cloud platforms. There are multiple factors driving this organizational transition to the cloud environment, including benefits such as cost reduction (Aljabre, 2012; Armbrust et al, 2010; Carcary, 2014; Conway, 2010; Geczy et al, 2012; Iyer 2010; Yang 2019), increased scalability and agility/adaptability ((Armbrust, 2010; Goscinski et al, 2010; Neves, 2011; Pyke, 2009; Su, 2011), improved resource utilisation (Armbrust, 2010; Kundra, 2011; Neves, 2012; Pyke, 2009), improved mobility and collaboration (Aljabre, 2012; Kynetix Technology Group, 2009; Neves, 2012), and business continuity and disaster recovery capabilities (Kynetix Technology Group, 2009). However, despite these potential benefits, cloud it is not a panacea for all of the problems faced by organizations. In fact, there are many barriers to successfully delivering cloud-based services (Brooks, 2010; Doherty 2015). Such barriers include concerns on security, privacy and data protection (Iyer, 2010; Armbrust et al, 2010; Conway, 2012; Su, 2011), business continuity due to the quality and availability of cloud service (Armbrust et al, 2010; Kynetix Technology Group, 2009), compliance with statutory and legal requirements and restrictions on the flow of data across boundaries (Iyer, 2010), lack of standardization leading to technology integration problems (Kynetix Technology Group, 2009; Su, 2011), and finally latency that may occur in transferring data packets (Armbrust et al, 2010; Yang & Tate,2009).

As cloud computing reflects a relatively new and rapidly evolving field presenting many challenges, few detailed guidelines or best practices currently exist to support an organization's migration to a cloud environment and its management thereafter. Some of these guidelines or approaches will now be examined.

2.2. Approaches to cloud implementation
Migration to the cloud computing environment reshapes a company's IT landscape. Hence, prior to transitioning to cloud, organizations need to weigh up the potential for benefits versus the associated barriers/challenges. As such, organizations need a systematic means of reviewing their business needs, so that the transition to cloud computing is strategically planned and managed throughout the migration, and the associated limitations are understood. Some prior studies have focused on areas such as strategies for cloud adoption (Conway, 2012; Iyer et al, 2010; Loebbecke et al, 2012) or cloud deployment and delivery models (Buyya et al, 2008; Leimeister et al, 2010). Other researchers have concentrated on specific cloud issues such as security (Almors et al, 2011), risk

management (Crowe Horwath et al, 2012), or have looked at specific areas such as Mobile clouds (Salehi, 2012). Other approaches are proprietary (e.g. Intel, Unisys, HP), or are based on existing frameworks such as ITIL.

3. Research approach

This study employed a qualitative research approach to the development of a cloud assessment framework. A workgroup of industry experts and academic thought leaders collaboratively undertook the development process. This workgroup was comprised of members of the Innovation Value Institute (IVI) global consortium which includes leading organizations from industry (including: Intel, The Boston Consulting Group, Ernst & Young, SQS, and Zilinx) and academia. The consortium uses an open innovation model of collaboration that engages academia and industry in scholarly work to amalgamate leading academic theory with corporate thought leadership to advance practices for managing IT for business value and innovation. A cloud workgroup, comprising of eight subject matter experts, followed a development process with defined review stages and development activities that were based on the Design Science Research (DSR) guidelines (Hevner, 2004). In addition to incorporating the insights of workgroup members throughout the development process, a qualitative approach to empirical data collection was adopted. Semi-structured interviews with cloud stakeholders across five organizations were conducted to capture the views of key domain experts and to understand current best practices, and the barriers to managing cloud projects. These included organizations that had both successfully delivered, and that had failed to deliver, cloud-based projects. The interview approach enabled depth, nuance and complexity to be captured (Mason, 2002), and the insights gathered were used to inform and revise the development of the assessment as described below.

In 2012 IVI announced the release of IT Capability Maturity Framework™ (IT-CMF™) which is an innovative and systematic framework, enabling CIOs/CEOs to understand and improve their organization's maturity and enable optimal business value realization from IT investments (Curley, 2004). IT-CMF™ provides a structure for managing the IT function within an organization to deliver greater value from IT by assessing and improving a broad range of management practices. The framework identifies 36 critical IT capabilities and defines maturity models for each capability. A core function of the IT-CMF™ is to act as an assessment tool and a management system. This research adopts and utilizes the capabilities as defined by IT-CMF™ and applies them for the specific requirements of cloud, see Appendix A for a brief description of IT-CMF™.

4. The Cloud Adoption Assessment
4.1 Overview
The Cloud Adoption Assessment was designed to cover three areas as described below and illustrated in Figure 1.
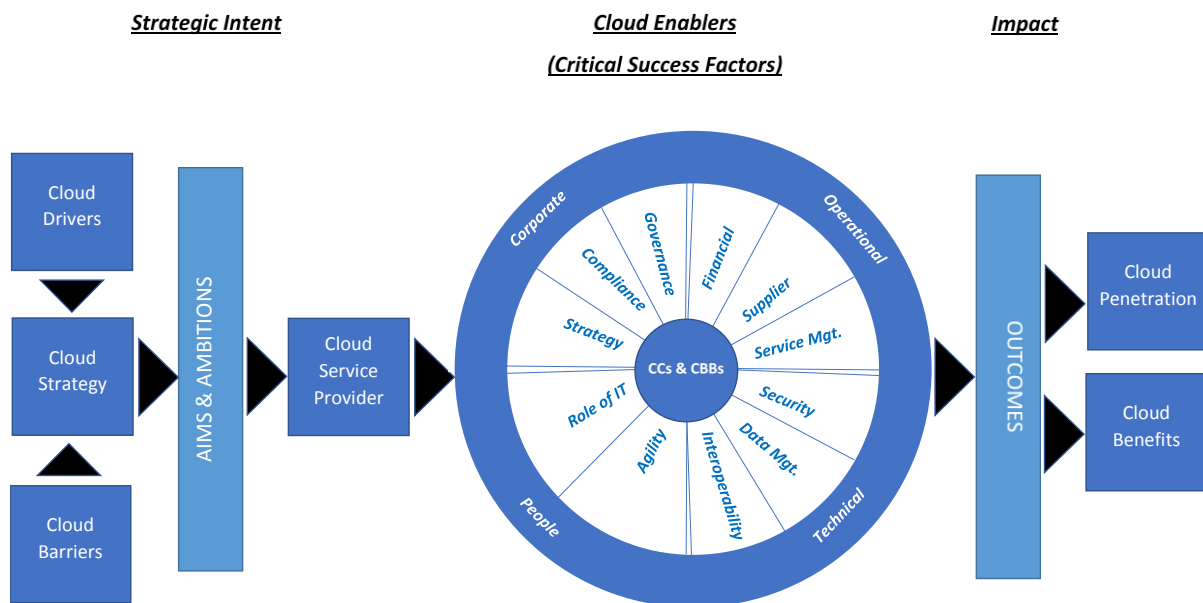

Figure 1: Cloud Adoption Assessment Model

Strategic intent: The first section concentrates on the implications and the strategic intent of moving to a cloud environment. It measures the extent to which an organization has considered and understood the specific drivers and barriers of using cloud, and how it uses this information to develop an appropriate strategy to address the drivers and to overcome the barriers. Having developed its strategy, the assessment then measures if the organization has the appropriate understanding and ability to choose a cloud service provider that can execute and deliver services and solutions based on this strategy.

Cloud enablers: The second section assesses the maturity of an organization using eleven critical success factors that have been identified as being key to the successful adoption and use of cloud. The critical success factors address the key business issues that organizations need to consider when they adopt and use cloud. They are as follows:

- *Strategic Planning* – Ensure that the strategic planning for cloud uses a unifying IT and business vision to identify suitable strategic options, programmes and technologies for the implementation and management of cloud.
- *Governance and Alignment* - Provide consistent direction and decision-making throughout the organization to accelerate the realization of the organization's strategic goals and objectives for cloud.
- *Security* – Check that appropriate security is in place to protect data, applications, and the associated infrastructure of cloud computing.
- *Regulatory & Legal compliance* – To ensure that the organization is fully compliant for all the data that it holds in the cloud, to cover requirements for the relevant jurisdictions and geographies, and to ensure that the cloud service providers are compliant.
- *Data Management and Protection* – To have specific systems and processes in place to ensure that cloud hosted data is protected and managed to conform to the overall needs of the organization and the specific challenges of the cloud environment.
- *Service Management* - Link the performance of business processes to the performance of the underlying cloud IT infrastructure and services. This provides an end-to-end view of cloud services enabling the organization to understand and manage how good cloud services conform to expectations.
- *Total Cost of Ownership* – Objectively measure savings by using a sophisticated cost model, that understands the current and future enterprise architecture, the capabilities of the cloud providers, and the impact of accounting and management changes that will come from switching services to the cloud.
- *Supplier Selection and Governance* – To ensure that the organization has the ability to evaluate, select, and manage cloud services providers.
- *Interoperability and Integration* – The process and systems that ensure the interoperability and integration, between cloud services, and between cloud and existing non-cloud services.
- *Agility* – Ensure that cloud services enhance the organization's ability to rapidly response to changing business conditions and opportunities.
- *Changing role of IT* – Ensure that IT lead initiatives to increase organizational efficiency, by ensuring systems and strategies – particularly around digitization and cloud – are working across the organization.

Impact: The final section looks at the actual or expected outcomes for an organization when they adopt and use cloud. The assessment measures the extent of the adoption of cloud technologies and services, and what benefits are expected, or have been realized by using cloud.

4.2. The Assessment Process
The Cloud Adoption Assessment is based on an online quantitative survey that is targeted to members of the organization's Business and IT leadership teams. The assessment findings are validated through tailored qualitative interviews and/or workshops that are facilitated by experienced cloud subject matter experts. The validated results for each of the assessment areas are compared to benchmark data gathered from several organizations across multiple sectors and geographies. The assessment results are compiled into a logical and easy to understand report that provides the organization with a comprehensive understanding of its current situation as well as clear, prioritized, and measurable improvement recommendations.

As stated earlier the cloud assessment is divided into three main sections with the first section measuring how well an organization has developed its aims and objectives for cloud, and the third section measuring what has been, or will be achieved by the adoption of cloud. The second section concentrates on the unique set of critical success factors for the adoption and use of cloud and the organization's maturity in relation to these factors. The following paragraphs describe how these maturity results are used to link the outputs to a set of prioritized capabilities and to develop a targeted improvement programme to ensure that cloud delivers the maximum value to the organization.

4.2.1. Linking the cloud critical success factors to capabilities
The cloud maturity section will identify and link the critical success factors to the IT-CMF™ capabilities (see Appendix A) as illustrated in Figure 2. For example, if *Strategy* and *Governance* has been identified as being the key priorities, then the most relevant capabilities are Strategic Planning (SP) and IT Leadership and Governance (ITG).
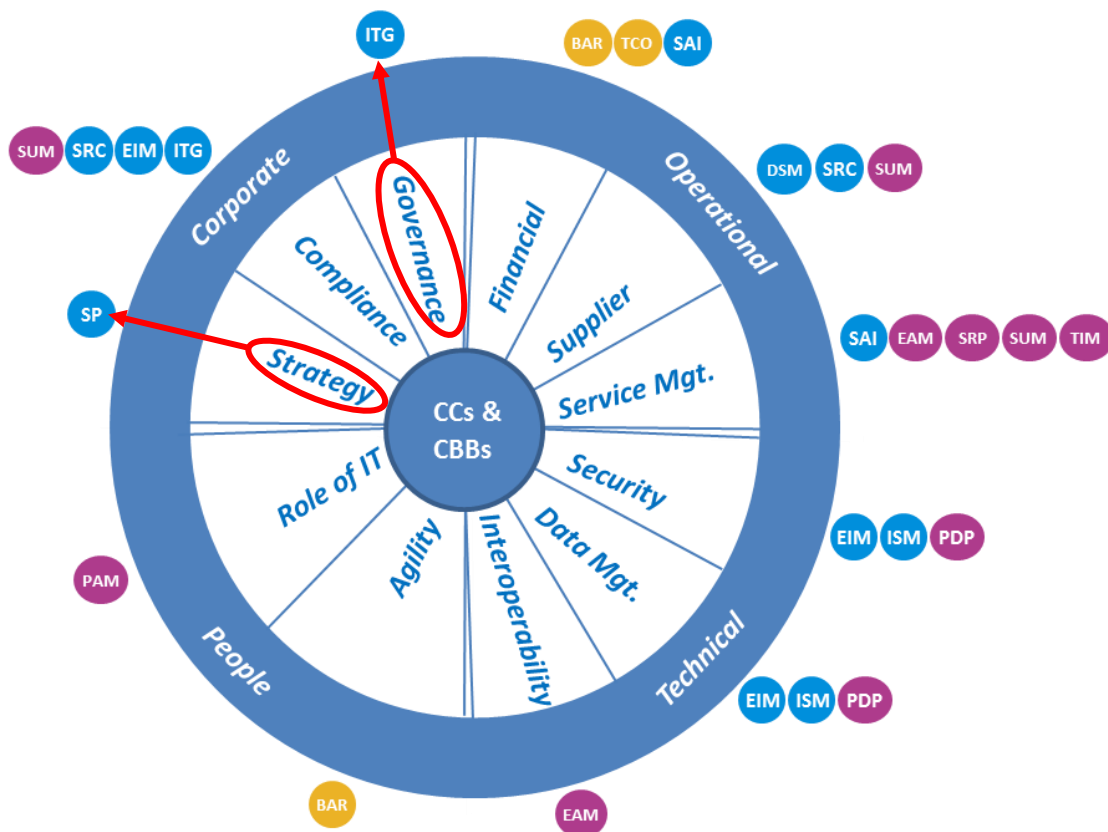

Figure 2: Linking Critical success factors to capabilities

4.2.2. Shortlist of Prioritized Capabilities and Recommended Improvements

The effective adoption and usage of cloud requires that an organization develops a wide-range of capabilities, which will vary in importance depending on the business context and the specific organization's needs. However, time and resource constraints will undoubtedly challenge organizations that attempt to develop multiple capabilities simultaneously, hence a key requirement is the need for the organization to focus on developing the capabilities of greatest importance. The Cloud Adoption Assessment will do this by linking the results of the assessment to improvement themes and their underlying capabilities. Figure 3 shows an example of how this can work in practice, so by using the Cloud Adoption Assessment Figure 3 highlights in red the key areas for improvement, for example *Cloud Drivers*, identifies the requirement for a *Dynamic Capability*, the *Cloud Strategy* identifies the organization's *Vision and Aims*, and so on.
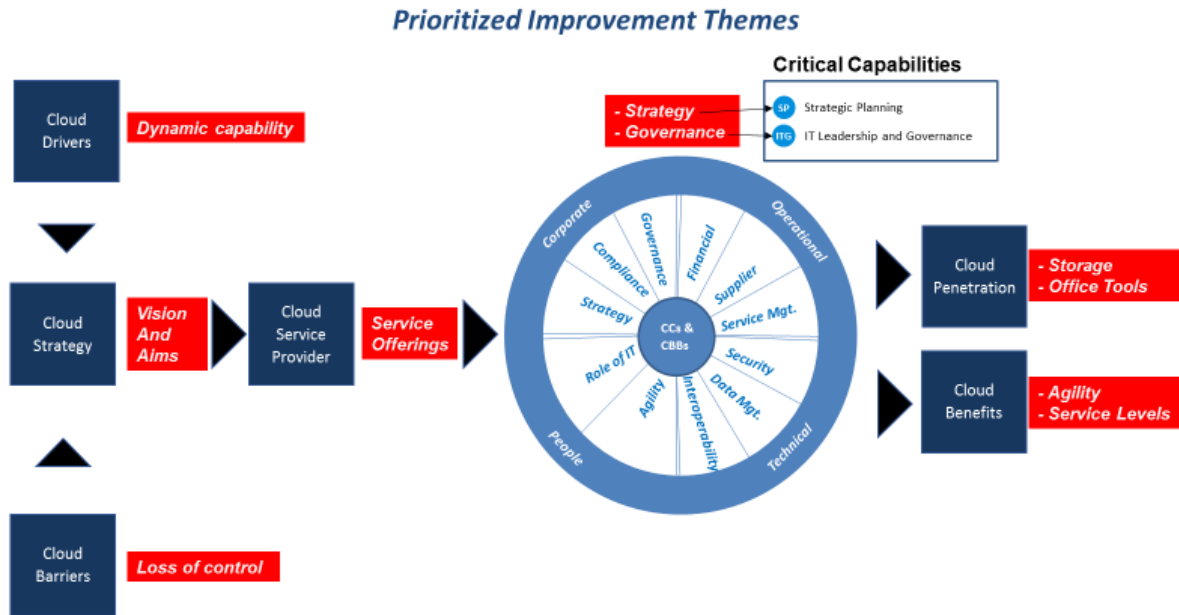
Figure 3: Illustrative Example of Prioritized Improvement Themes

To illustrate this further, *Strategy* and *Governance* were highlighted as being key priority areas, hence the respective priority capabilities for improvement are *Strategic Planning* (SP) and *IT Leadership and Governance* (ITG) which is then used to generate the themes for an improvement program as illustrated in Figure 4.
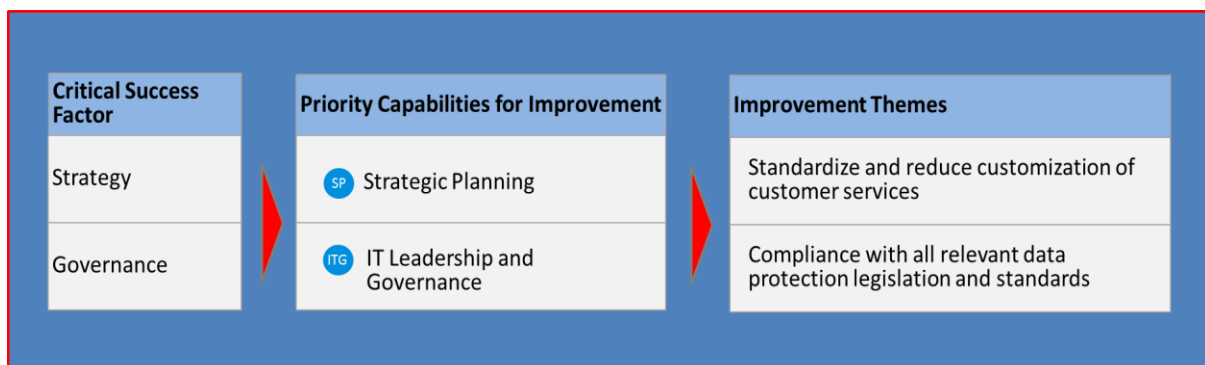

Figure 4: Illustrative Example of Prioritized Improvement Themes

5. Discussion and Conclusions

Cloud computing is a paradigm shift in IT services delivery. This shift promises large gains in agility, efficiency and flexibility at a time when demands on IT and its resources are growing exponentially. By successfully adopting and using cloud, organizations can remain competitive by continually delivering value to its customers and stakeholders.

As highlighted in the literature there are various cloud approaches that can be used by an organization, however these frameworks do not offer the holistic approach required to transition and manage a cloud computing environment. Consequently, this paper presents a framework developed by key academics and industry practitioners using a Design Science approach to address this gap.

The Cloud Adoption Assessment provides an organization with a management tool to enable a better understanding of their enterprise IT capability maturity to position, evaluate, introduce, and manage cloud services, and their associated strengths and weaknesses in these areas. The assessment further provides organizations with practical improvement roadmaps for the migration and management of cloud, that are grounded in industry best practice at a detailed level of prescription.

Whilst the assessment does not propose to address all the issues faced by an organization when implementing and managing cloud, it is proposed as a good starting point in the transition and subsequent management of the cloud environment. It should be noted that the study was centred on a small sample size and was primarily focused on larger multinational organizations.

The study and the subsequent cloud adoption assessment adds vaue to academics as it sheds light on an area where there has not been a lot of research, specifically in the transition to a cloud computing enviornment. From an industry perspective it is hoped that researchers in this area will use this assessment and provide further validation through its use.

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Appendix A.

IT-Capability Maturity Framework (IT-CMF™) - is a comprehensive suite of proven management practices, assessment approaches and improvement strategies covering 36 management disciplines or Critical Capabilities (CCs) as shown in Figure 5. For each capability, IT-CMF incorporates a comprehensive suite of maturity profiles, assessment methods, and improvement roadmaps – these are expressed in business language that can be used to guide discussions on setting goals and evaluating performance.

The shortlisted capabilities identified in the Cloud Adoption Assessment are drawn from IT-CMF™. Each capability is broken down into a series of capability building blocks, together with a comprehensive body of knowledge to drive improvement. This includes indicative improvement practices, outcomes and metrics, capability performance indicators, and supporting management artefacts. Currently, global organizations are using IT-CMF™ to support the improved business management of IT. This use in turn helps inform the on-going development of IT-CMF™, which leverages an open innovation and collaborative research approach between academic researchers and industry-based practitioners – ensuring the principles underpinning the framework are informed by leading insights and best-known practices.

Managing IT like a Business
- AA Accounting and Allocation
- BP Business Planning
- BPM Business Process Management
- CFP Capacity Forecasting and Planning
- DSM Demand and Supply Management
- EIM Enterprise Information Management
- GIT Green IT
- IM Innovation Management
- ITG IT Leadership and Governance
- ODP Organization Design and Planning
- RM Risk Management
- SAI Service Analytics and Intelligence
- SRC Sourcing
- SP Strategic Planning

Managing the IT Budget
- BGM Budget Management
- BOP Budget Oversight and Performance Analysis
- FF Funding and Financing
- PPP Portfolio Planning and Prioritization

Managing the IT Capability
- CAM Capability Assessment Management
- EAM Enterprise Architecture Management
- ISM Information Security Management
- KAM Knowledge Asset Management
- PAM People Asset Management
- PDP Personal Data Protection
- PPM Programme and Project Management
- REM Relationship Management
- RDE Research, Development, and Engineering
- SRP Service Provisioning
- SD Solutions Delivery
- SUM Supplier Management
- TIM Technical Infrastructure Management
- UED User Experience Design
- UTM User Training Management

Managing IT for Business Value
- BAR Benefits Assessment and Realization
- PM Portfolio Management
- TCO Total Cost of Ownership

Figure 5: *IT-Capability Maturity Framework (IT-CMF™)*