Paper 01

Towards an integrated maturity model of asset management capabilities

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Abstract Asset service organisations often recognize asset management as a core competence to deliver benefits to their business. But how do organizations know whether their asset management processes are adequate? Asset management maturity models, which combine best practices and competencies, provide a useful approach to test the capacity of organisations to manage their assets. Asset management frameworks are required to meet the dynamic challenges of managing assets in contemporary society. Although existing models are subject to wide variations in their implementation and sophistication, they also display a distinct weakness in that they tend to focus primarily on the operational and technical level and neglect the levels of strategy, policy and governance as well as the social and human resources – the people elements. Moreover, asset management maturity models have to respond to the external environmental factors, including such as climate change and sustainability, stakeholders and community demand management. Drawing on five dimensions of effective asset management – spatial, temporal, organisational, statistical, and evaluation – as identified by Amadi-Echendu et al. [1], this paper carries out a comprehensive comparative analysis of six existing maturity models to identify the gaps in key process areas. Results suggest incorporating these into an integrated approach to assess the maturity of asset-intensive organizations. It is contended that the adoption of an integrated asset management maturity model will enhance effective and efficient delivery of services.

1 Introduction

Asset service organizations face compounding challenges to ensure a sustainable balance between investment in new asset services and the need to maintain existing delivery of services at an optimal life cycle cost and quality while meeting community expectations. These challenges have placed significant pressures on organisations to improve the effectiveness of managing their infrastructure inventory through adopting more efficient, sustainable, and proactive engineering asset management (EAM) strategies. These challenges are due to the fact that these or-

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ganizations have to deal with the growing concerns about resource scarcity, degrading environment, climate change, more stringent regulations, and a greater reliance on a multi-agency delivery model [2], [3], [4]. As a result, asset-intensive organisations are looking to improve their performance capabilities.

Assessing the maturity of an asset-intensive organisation through the adoption of a capability maturity model is a practice that not only most effectively manages the resources; it supports the continual improvement in asset management performance. The Capability Maturity Model is defined as an approach to assess the stages of development of business processes in organisations and a framework to improve processes through structuring a pre-defined set of levels. According to Hilson [5], the purpose of using a maturity model is to assess the current capability, strengths and weakness, and analyse gaps for improvement where it is required. In essence, these models are collections of best practices that help organizations to improve effectiveness, efficiency, and quality. A maturity model can thus be viewed as a set of structured levels that describe how well different processes of an organisation are able to achieve staged outcomes in a reliable and sustainable way.

"EAM can be defined as the process of organising, planning and controlling the acquisition, care, refurbishment, and disposal of infrastructure and engineering assets. It is a systematic, structured process covering the whole life of physical assets (p.2)" [2]. Amadi-Echendu et al. [1] highlight five dimensions of EAM: spatial (consider all types of physical asset including interaction between the asset and stakeholders and clients, sustainability, industrial sector, and the government), temporal (consider short term aspect such as operational management and long term aspect such as strategic management of engineering assets), evaluation (consider financial measurement and capability measurement including social and physical capabilities), statistical (embedded in analysis process of risk) and organisational (including overall organisational management, the technology and information management, and the human factors management) [1], [6]. To assess the performance of an asset service organization's capabilities, this set of five dimensions is considered to be both comprehensive and crucial. There are growing numbers of maturity models being developed to assist with the assessment of how mature an organization is. However, the question is whether the existing capability maturity models for asset management met the five elements standard and consider all the dimensions in their processes. To answer this question this paper undertakes a comparative study of existing asset management maturity models against the five dimensions of EAM to identify the gaps in terms of key process areas and to suggest incorporating all the key process areas for a more integrated approach to assess maturity of asset-intensive organizations. It is envisaged that the results of this analysis will better inform those practitioners in industry and academic researchers concerned with process improvement, intervention, and change management in organizations.

The paper proceeds as follows: the next section briefly describes the typical structure of a capability maturity model. This examination is followed by the methodology, which highlights the key process areas of EAM. Then in the next

section, we compare some of the existing asset management maturity models against the different key process areas of EAM and identify the gaps for improvement. The paper concludes with a proposal for an integrated capability maturity model for asset management. Vibration and noise radiation from diesel engines due to piston slap has been studied for several decades.

2 Capability maturity models

Capability maturity models (CMM) were first developed to objectively assess contractors' ability in undertaking software development projects [7]. Since then, capability maturity models have been widely used across a broad array of areas. In most cases, maturity is used in capability maturity models in the very technical sense to mean "the extent to which an organization has explicitly and consistently deployed processes that are documented, managed, measured, controlled, and continually improved" [8]. According to Paulk et al. [7], a capability maturity model is built upon five components: pre-determined maturity levels, key process areas, goals, common features and key practices. In this paper, we compare different asset management maturity models against the key process areas under five dimensions of asset management. As the key process areas provide the useful information for understanding different dimensions of EAM, we will use these to compare different capability maturity models. A key process area can be defined as the group of related activities that, when performed together, achieve a set of goals.

3 Methodology

3.1 Selection of the asset management maturity models

There have been a number of capability maturity model developed in the area of engineering asset management. From the list of potential models, we selected maturity models for comparative analysis that fulfilled the two criteria: Relativity (consider the capability maturity models which are developed fully or partially in relation to the EAM) and Publicly Available (many maturity models are proprietary tools generated by consulting organisations. We consider only those maturity models that are in the public domain and available without cost).

In this paper, six maturity models are considered for a comprehensive comparative study. They are categorised as in the EAM field such as the PAS 55-BSI (Publicly Available Specification 55-BSI), AMMM-OARSIK (Asset Management Maturity Model-OARSIK), PAMMM-OGC (Property Asset Management Maturity Matrix-OGC), AMM-IBM (Asset Management Maturity-IBM), AMM-SKF

(Asset Maturity Management-SKF), and PAMCAM-OGC (Property Asset Management Capability Model-OGC).

3.2 Dimensions and key process areas

The increasing complexity and sophistication of EAM processes has resulted in the creation of diverse areas of knowledge, expertise, and responsibilities within and across organizations. As a result, a state of process fragmentation has been created, and much inefficiency has subsequently arisen primarily due to the disintegration of process areas. An integrated approach to asset management can potentially eliminate many of the fragmentation inefficiencies by enabling the integration of processes. These dimensions and process areas of asset management, which are derived from the systematic review of extensive literature on asset management, have been concisely summarized in Table 1.

Table 1. Dimensions and process areas of asset management

Dimensions	Elements	Process Areas
Spatial	Community Needs and Expectations	Stakeholder Management[9]; Demand Management[10]
	Environmental Factors	Sustainability Management[11]; Climate Change [12]
	Organizational Governance	Interagency Collaboration[13]
	Whole-of-Government Policy Framework	Whole-of-Government Policy and Whole-of-Government Model[14]
Temporal	Service Delivery Planning	Asset Management Policy[15]; Asset Management Objectives[16]; Asset Management Strategy[17]; Acquisition Plan[18]; Operations Plan[18]; Maintenance Plan[16]; Disposal Plan[18]
	Service Delivery	Performance and Condition Monitoring [19]; Incident Management[19]; Corrective and Preventive Actions[20]; Procurement[18]
Organisational	Organisational Governance	Corporate Governance[21]; Corporate Policy[22]; Corporate Strategy[15]
	Knowledge Management	Data Management[20]; Asset Register[23]; Information Systems[24]; Knowledge Management[25]
	Organizational Management	Leadership[26]; Change Management[27]; Competence Management[28]; Organisational Culture[29]
Statistical Evaluation	Environmental Factors Evaluation	Risk Management[30]; Asset Performance Measurement[31]; Management Reporting[32]; Review[2]; Audit[33]

3.3 Evaluation of the maturity models

Content analysis of the related documents of the maturity models was carried out to identify the key process areas of the selected maturity models. According to Julien [34], a content analytic approach recognizes that text is open to subjective interpretation and reflects multiple meanings. For reliable evaluation of process of maturity models, in this paper, three authors carried out the contextual analysis individually and provided their ratings on the availability of the key process areas against the comprehensive list of key process areas. Later, these ratings were cross checked and any discrepancies found in the evaluation were solved by consensus of the majority.

4 Findings

It is evident from Table 2 that all selected models incorporate process areas related to data management, asset register and information systems. However, while all models focus on the asset data and knowledge standards related to data quality and standards for collecting, categorising and providing asset information, but they do not deal with the more human driven knowledge management aspects such as education and communication, trust-building and team enabling activities. Moreover, demand management under the spatial dimension, which is part of the forecasting long term and short term service demand, is not addressed in any of the models. The key process areas under the evaluation dimension are widely covered in almost all the maturity models described here with exceptions of AMM-IBM and AMM-SKF. The authors found that all the maturity models have the strong asset performance measurement process areas. However, apart from the risk management, the process areas related to the environmental factors in the form of sustainability management and climate change are overlooked in all the maturity models that are considered in this paper.

Compared to the other capability maturity models, the PAS55-BSI is the most comprehensive as it considers all the key process areas addressed under the temporal (in the form of service delivery planning and service delivery) and evaluation dimensions. Moreover, the model incorporates process areas related to the whole-of-life cycle asset management plans (acquisition, operations, maintenance and disposal plans). However, key process areas related to organizational governance (corporate governance, corporate policy and corporate strategy, and interagency collaboration) are not considered in this model. As part of the organizational management process area, this model considers the change management and competence management but not the leadership and organizational culture, which means the model is lacking in two important process areas related to human aspects.

Table 2. Comparison of six asset management maturity models

Elements (Dimension)	Key Process Areas	PAS 55-BSI	AMMM-OARISK	PAMMM-OGC	AMM- IBM	AMM- SKF	PAMCAM-OGC
Service Delivery Planning (Temporal)	Asset management policy	×	×	×			
	Asset management objectives	×	×	×			
	Asset management strategy	×	×	×	×	×	×
	Acquisition plan	×	×	×			×
	Operations plan	×	×	×	×	×	×
	Maintenance plan	×	×	×	×	×	×
	Disposal plan	×		×			
Service Delivery (Temporal)	Performance and condition monitoring	×	×	×	×	×	×
	Incident Management	×				×	
	Corrective and preventive actions	×		×	×	×	×
	Procurement	×	×	×			×
Organizational Governance (Organizational)	Corporate governance			×			×
	Corporate policy			×			×
	Corporate strategy			×			×
	Interagency collaboration						
Knowledge Management (organizational)	Data management	×	×	×	×	×	×
	Asset register	×	×	×	×	×	×
	Information systems	×	×	×	×	×	×
	Knowledge management						
Organizational Management (Organizational)	Leadership		×			×	
	Change management	×				×	
	Competence management	×	×		×	×	×
	Asset management culture					×	
Environmental Factors (Statistical/ Spatial)	Risk management	×	×	×	×	×	
	Sustainability management						
	Climate change						
Community Needs and Expectations (Spatial)	Stakeholder management	×					×
	Demand management						
Whole-of-Government	Whole-of-Government Policy	×				×	×

Policy Framework (Spatial)	Whole-of-Government Model	×				×	×
Evaluation (Evaluation)	Asset Performance Measurement	×	×	×	×	×	×
	Management Reporting	×	×	×		×	×
	Review	×	×	×	×		×
	Audit	×	×	×			×

The next comprehensive maturity models are PAMMM-OGC and PAMCAM-OGC. In contrast to PAS55-BSI, these two models start from the organizational strategic governance (corporate governance, corporate policy and corporate strategy) to asset management strategy. Similar to the PAS55-BSI, these two models have the whole-life- cycle asset management plans. The process areas related to the organizational management and community needs and expectations are not considered in the PAMMM-OGC. As part of the process areas related to the organizational management, only competence management process area and stakeholder management under the community needs and expectations are taken into consideration in PAMCAM-OGC. It is clear that process areas related to human and social aspect are not fully covered in these two models.

The remaining maturity models (AMM-OARSIK, AMM-IBM and AMM-SKF) provide mixed findings in relation to their suitability in attaining integrated process areas. None of these three models have process areas related to organizational governance and nor do they consider whole-of-life cycle management plans in their process areas. In terms of process areas related to organizational management, AMM-SKF is more comprehensive than other maturity models in the list as the model covers all the process areas in the form of leadership, change management, competence management and asset management culture.

It is apparent from the comparative study that none of the maturity models have fully incorporated all the process areas against the five key dimensions. The desire to implement efficient and optimized asset management service delivery has created a strong demand for “bridging the gaps” through the adoption of integrated approaches. There is a need for a comprehensive asset management capability maturity model (AMCaMM) which considers all of the five dimensions of asset management mentioned earlier. To secure optimal benefit from a capability maturity model, it is obvious that the model which covers comprehensive process areas of asset management is more effective.

5 Summary and Conclusion

In summary, the strategic level issues apart from the PAMMM-OGC and PAMCAM-OGC start only at the asset management level in the form of asset management policy, objective and strategy but not at the strategic asset governance in the form of corporate governance and related corporate policies, objectives

and strategies. Furthermore, life cycle asset management plans are only considered in two maturity models, namely PAS55-BSI and PAMMM-OGC. Moreover, there are gaps associated with the process areas related to human and social issues in all the maturity models.

The integration of the process areas can be useful for achieving mature asset service organizations. The implications are that mature organizations are able to: Manage all the projects undertaken by an organization effectively [35]; improve continually the performance of all projects undertaken by an organization and improve dialogue between the project management community and an organization's top management [36]. Therefore, the authors argue for an integrated AMCaMM based on a combination of all the process areas using all five dimensions of EAM. The paper concludes that a well-designed capability model for managing assets should include broader contextual elements and address higher level organisational management levels by integrating corporate planning processes with their asset planning processes. Further research is required to establish the different graduations of maturity along a scale and how the different bundles of processes within each level of the scale should be assessed for maturity. The central unifying theme of the AMCaMM is the development of managerial and strategic solutions to the social and human issues along with the technical issues that potentially enhance an organization's ability to manage their engineering assets.

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