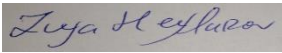




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Application of the ISO 55000 suite for digital asset management

By

Ziya Heydarov

A Thesis

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Abstract

Historically, physical and financial assets were accepted to be the fundament of personal and corporate wealth and power. It was all about keeping buildings and equipment maintained. The primary goal was to keep production profitable and earning money. However, many factors, such as technological development, environmental awareness, market conditions, human rights, and government regulations raised a need for coordinated and effective asset management practices. Publication of the PAS55 and ISO 55000 suite was the first deliberate steps of the international asset management community towards utilization of coordinated, integrated and not least, internationally accepted asset management practices. ISO 55000 suite became a framework for further development and improvement of the physical asset management practices worldwide. Implementation of asset management practices and application of ISO 55000 suite for physical asset management brought great value to organizations in the form of improved performance, efficiency and effectiveness, risk management, decision making processes and compliance with regulations.

Constant aim for competitive advantage in the world accelerated the development of information technology and led to new trends called “digitization” and “digital transformation”. Already in 2007, 94% of the world’s information storage was in digital format. All intangible and intellectual property assets, such as trade secrets are being stored in a digital format. Industrial espionage is not about stealing papers anymore, it is about stealing digital data and information. It is becoming clear that knowledge, competence and intellectual property are becoming the most significant factors for success and competitive advantage. A new type of assets – digital assets are becoming an essential part of every company

However, how do organizations manage their digital assets? What kind of framework can be applied for digital asset management? Are digital asset management concepts, frameworks and practices as developed as for physical assets?

ISO 55000 (2014, p.1) creators highlight that the standard was predominantly developed for managing physical assets, but it can also be applied to other asset types. In that case, it could be interesting to evaluate the application of ISO 55000 suite for digital asset management.

The main aim of this thesis is to evaluate application of ISO 55000 suite (2014) for digital asset management. Evaluation is done by assessing and mapping the digital asset management practices in Baker Hughes, GE Company (BHGE) against requirements of the ISO 55001

(2014). The thesis provides an overview of digital asset management practices in BHGE with regards to the requirements of ISO 55001 (2014). As a part of the thesis work, the subjects of asset and digital asset; asset management and digital asset management have been explored by an extensive review of literature and the internet.

This thesis has contributed to the understanding of digital asset management topic and research with regards to the application of ISO 55000 suite (2014) for digital asset management. Organizations can, in general, assess the maturity of their digital asset management practices by utilizing the evaluation method described in this thesis.

Acknowledgments

This report is my almost final step towards completion of master's degree in Technology and Operations Management at University of Stavanger. I will need to take one last subject during Spring of 2019. I am very happy that I decided to start my master's program in 2016. The program has given me a broader perspective in many subjects which will be useful in my private and professional life.

I would like to thank Professor Jayantha.P. Liyanage from the University of Stavanger for his guidance and advises that helped me to structure my thoughts and deliver this thesis.

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Abbreviations

BHGE	Baker Hughes, GE Company
BSI	British Standards Institution
DAM	Digital Asset Management
FMECA	Failure Mode, Effects, and Criticality Analysis
GFMAM	Global Forum on Maintenance and Asset Management
HAZID	Hazard Identification Studies
IAM	Institute of Asset Management
IP	Intellectual Property
ISO	International Organization for Standardization
IT	Information Technology
OFE BHGE	Oilfield Equipment division of Baker Hughes, GE Company
PAS	Publicly Available Specification
RCA	Root Cause Analysis
SAMP	Strategic Asset Management Plan

1 Introduction

1.1 Background

Publication of the PAS55 and ISO 55000 suite led to the implementation and utilization of a globally accepted framework for physical asset management. This framework was long awaited since the global asset management community lacked guidance and benchmark for physical asset management in general. The framework of ISO 55000 suite introduced a set of fundamental principles that are focusing on:

- The value that assets can provide to the organizations;
- Alignment of asset related technical and financial decisions, plans and activities with the organizational objectives;
- Leadership and workplace culture that is essential in establishing, operating and improving the asset management in the organizations;
- Assurance that the assets will accomplish their required purpose.

Numerous hard evidences are showing that utilization of PAS 55 and ISO 55000 suite led to positive impacts. Woodhouse (2013, p.4) highlights CPL Hong Kong, Nuon Holland and New South Wales government to be amongst organizations that achieved remarkable results due to concentrated efforts to improve asset management practices. Certification to ISO 550001 brought numerous improvements to:

- Genève Aéroport (ISOfocus, 2017);
- Network Rail, an infrastructure manager of the railway network in Great Britain (nvfnorden.org, 2016);
- University Health System, a public district hospital in San Antonio, Texas (business-benefits.org, n.d.);
- Scottish Water, a corporation that provides water and sewerage services across Scotland (business-benefits.org, n.d.).

The sole goal of developing and improving asset management practices is to strengthen the competitive advantage. Constant aim for the competitive advantage in the world accelerated the development of information technology and led to a new trend called “digitization” and “digital transformation.” Nowadays every single piece of information, including knowledge,

competence and intellectual property, is being created in a digital format or being converted to a digital format almost immediately after creation. Data and information, and ability to use these have become an important factor for gaining competitive advantage. A new type of assets – digital assets are becoming an important part of every organization

Trade secrets, such as design, manufacturing and operational details and processes, are one of the most valuable digital assets for an organization that develops and sells products. These digital assets help to produce products and services with unique features and specifications that bring competitive advantage. If an organization loses all its trade secrets, the position of that organization in the market will be weakened and in the worst case, this may lead to the end of the organization. At the same time, the quality of the design and manufacturing processes has a direct impact on the stakeholders' perception about the company, and reliability and safety of the products it produces. To gain stakeholders' trust and approval, and to ensure positive development and growth of the organization, it is essential to provide adequate management of the digital assets, such as trade secrets.

While organizations utilize the guidance and requirements of ISO 55000 suite for improving their physical asset management practices, the condition of their digital asset management practices is unclear. ISO 55000 (2014, p.1) creators highlight that the standard was predominantly developed for physical asset management, but it can also be applied to other asset types. In that case, it could be interesting to evaluate the application of ISO 55000 suite for digital asset management.

1.2 Aim of Thesis

The main aim of this thesis is to assess the application of ISO 55000 suite (2014) for digital asset management. Assessment is done by evaluating and mapping the digital asset management practices in BHGE against requirements of the ISO 55001 (2014). The thesis provides an overview of gaps and improvement potential of the digital asset management practices in BHGE with regards to the requirements of ISO 55001 (2014). As a part of the thesis work, the subjects of asset and digital asset; asset management and digital asset management have been explored by an extensive review of literature and the internet.

This thesis has contributed to the understanding of digital asset management topic and research with regards to the application of ISO 55000 suite for digital asset management.

Organizations can, in general, assess the maturity of their digital asset management practices by utilizing the evaluation method described in this thesis.

1.3 Scope of Work

Following is the scope of the work in this thesis:

- To review the literature on the discipline of asset management, including the definitions, history and development, scope and benefits;
- To gain a general understanding of subjects of digital and intellectual property assets and digital asset management;
- To conduct a detailed study of ISO 55000 suite (2014) and specifically, to review all clauses and requirements in ISO 55001 (2014);
- To analyze the digital asset management practices in the Oilfield Equipment division in Baker Hughes, GE Company (OFE BHGE) and identify gaps and improvement potential.
- To discuss the applicability of the ISO 55000 for digital asset management.
- To recommend future study work in the field of digital asset management.

1.4 Thesis Structure and Methodology

This thesis consists of four areas of focus:

- 1) Introduction to this thesis is provided in Abstract and Chapter 1 “Introduction”. The goal of these sections is to provide background information of the problem that leads to the study and research;
- 2) Chapter 2 “Asset” and Chapter 3 “Asset Management” focus on the theoretical basis of this thesis. An extensive review of the academic and industrial literature, and online sources is reflected in Chapter 2 “Asset”. This chapter elaborates subjects of asset in general, physical and digital assets, and digital intellectual property assets. Detailed study of ISO 55000 suite (2014) together with review of literature and online sources are the basis of Chapter 3 “Asset Management”. This chapter explains the idea of asset

- management, asset management system, explores the subject of “Digital Asset Management” and analytically elaborates all 24 clauses of the ISO 55001;
- 3) Chapters 4 “Approach for Analyzing Digital Asset Management Practices” and 5 “Analysis and Results” focus on the method for analyzing and the analysis of the digital asset management practices in OFE BHGE. To assess the digital asset management practices in OFE BHGE, a team responsible for the digital asset management in the engineering organization of the company was interviewed. Requirements in the 24 clauses of ISO 55001 (2014) were converted into specific questions that would help to evaluate organization’s digital asset management practices against the requirements of this standard. In order to compute the results of the analysis, a rating process that reflects the level of the compliance with requirements of ISO 55001 (2014) was utilized. Chapter 4 “Approach for Analyzing Digital Asset Management Practices” describes the method of the analysis and rating in details. Chapter 5 “Analysis and Results” contains the analysis of the digital asset management practices in BHGE, summarizes the input that was received during the interview process, discusses gaps and improvement areas that were observed;
 - 4) Chapters 6 “Discussions, Observations and Suggestions for Further Studies” and 7 “Conclusion” are the final chapter of this thesis. Chapter 6.2 “Observations and Findings” discusses the findings of the thesis with regards to the applicability of the ISO 55000 suite for digital asset management. In addition, it contains an overview of gaps and improvement potential in OFE BHGE with regards to digital asset management, observations and findings that were made during the research work, and suggestions for the future work. Chapter 7 “Conclusion” provides final remarks and a short conclusion with regards to the content of this thesis.

1.5 Limitations

To keep the scope of the thesis within a manageable frame, the following limitations were introduced to the thesis work:

- The analysis of the digital asset management practice is strictly limited to the requirements of the ISO 55001 (2014). The thesis does not consider all 72 “shall”

statements of ISO 55001 (2014) in the questionnaire that was created for the interview, but instead extracts the essence and main points of each clause;

- The analysis of the digital asset management practices is limited to the engineering organization in Oilfield Equipment division in BHGE. This was done because the engineering organization creates the most amount of digital assets that belong to Oilfield Equipment division in BHGE. The digital assets that are created by engineering organization are confidential and classified as intellectual property. These digital assets mainly consist of trade secrets;
- Although IT systems and tools are an important part of a digital asset management system, this thesis does not explicitly address IT related issues or their significance in the subject of the digital asset management;
- The identity of the interviewees will not be revealed in this thesis;
- The author of this thesis did not have all necessary resources or opportunity to evaluate and confirm all the answers that were provided during the interview. The interview results may have some degree of subjectivity due to personal interpretations;
- Even though an agreement concerning the restricted access to this document was signed between the author of this thesis, OFE BHGE and UiS, the company was unwilling to let some of the evidences of compliance to be published in this thesis due to the level of confidentiality and sensitivity. Front pages of some documents that were provided as evidences are attached to the thesis with hidden document numbers, author names and content. However, it was made clear that the evidences can be shown in premises of OFE BHGE upon request, without any right for any further copy.
- This thesis does not perform an in-depth analysis regarding the state of the art of the digital asset management. The primary goal of this thesis is to evaluate the applicability of the ISO 55000 suite for managing digital assets.

1.6 About the Company

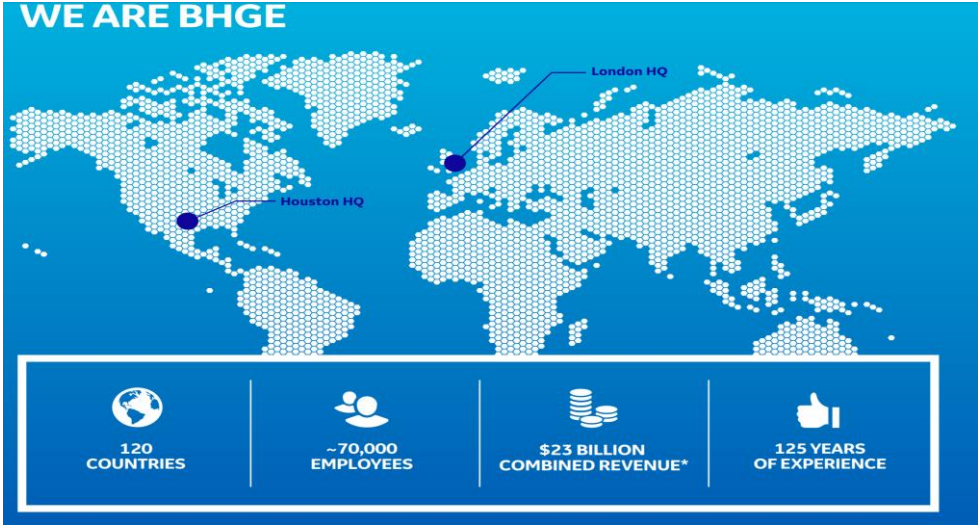


Figure 1 BHGE – Fullstream provider of integrated oilfield products, services and digital solutions (Bhge.com, n.d.)

Baker Hughes, a GE company (NYSE:BHGE) is the world’s first and only fullstream provider of integrated oilfield products, services and digital solutions (BHGE.com, n.d.). Company was created because of a merger between GE Oil & Gas and Baker Hughes in 2017. Company consist of following product and services divisions:

- Oilfield Services that provide drilling, wireline and wellbore intervention services, and develop products corresponding to these services, etc.
- Turbomachinery & Process Solutions that develop and deliver turbomachinery and process equipment together, services, etc.
- Digital Solutions that develop and deliver sensors, measurement equipment, inspection technology and condition monitoring equipment, etc.
- Oilfield Equipment that deliver subsea productions systems, subsea services, subsea drilling systems, etc.

Table 1 provides an insight to BHGE’s operational and financial scale for the third quarter in 2018

<i>(in millions)</i>	Three Months Ended			Variance	
	September 30, 2018	June 30, 2018	September 30, 2017	Sequential	Year-over-year
Consolidated segment orders					
Oilfield Services	\$ 3,011	\$ 2,866	\$ 2,734	5 %	10 %
Oilfield Equipment	553	1,035	760	(47)%	(27)%
Turbomachinery & Process Solutions	1,552	1,498	1,334	4 %	16 %
Digital Solutions	629	637	918	(1)%	(31)%
Total	\$ 5,746	\$ 6,036	\$ 5,745	(5)%	— %

Table 1 BHGE, financial results by reporting segment, third quarter 2018 (Bhge.com, 2018)

As the part of this thesis, it is Oilfield Equipment (OFE) division that has been evaluated for the digital assets management practices. Engineering organization of the OFE creates, and is responsible for further maintenance of most of the digital assets that predominantly consist of, but not limited to, trade secrets such as:

- Bill of materials and the list of all vendors that provide subcomponents;
- Drawings, such as assembly, subassembly, detail weldment, detail machine, forging, hydraulic and electric schematics, layout, interface, etc.;
- Design verification packages, such as design criteria, guidelines and procedures, etc.;
- Field service manuals, such as disassemble/assemble manuals, offshore maintenance procedures, operating and service procedures, product design information, pre-operational check, etc.;
- Internal standards, such as design, material, coating, welding and non-destructive examination standards, fabrication operations, fabrication and test practices, and technical qualification procedures;
- Quality records, such as inspection checklists, quality assurance procedures, etc.;
- Software;
- Technical records, such as design and analysis reports, design datasheets and checklists, design processes, design specifications and requirements, risk analysis, etc.;
- Other kind of technical data and documentation that has value for OFE division that develops and delivers products, as well as provides services related to these products

Digital assets that are being created by engineering department are being uploaded to a set of IT applications that make it possible to access all the assets in the future.

2 Asset

2.1 Asset Definition

By reviewing the definition of asset in Cambridge dictionary (n.d.), Oxford dictionary (n.d.) and ISO 55000 (2014, p.13) one can conclude that an asset is anything that has a value to a person and an organization throughout the life of this asset. The asset life covers the time span from its' creation to its' end of life. The value of an asset can be defined in monetary units, depending on the price that it can be sold for or by asset's ability to produce value to its owners. As it is stated in ISO 55000 (2014, p.1), what constitutes value will depend on these objectives, the nature and purpose of the organization and the needs and expectations of its stakeholders.

ISO 55000 (2014, p.13) defines asset type to be grouping of assets with common characteristics that distinguish those assets as a group or class, and provides examples of assets such as information assets, intangible assets, critical assets, enabling assets, linear assets, information and communications technology assets, infrastructure assets, moveable assets.

With reference to corporatefinanceinstitute.com (n.d.) and efinancemanagement.com (n.d.), in financial balance sheets assets are classified in accordance with their nature and type:

- From the point of view of convertibility into cash, assets can be current or fixed. Current assets are assets that are in cash or expected to be converted to cash within one accounting year. Typical examples are cash in bank accounts, shares, inventory, etc.
- Fixed assets are long term assets that cannot be easily converted into cash and are needed for operations of the company. Typical examples of fixed asset are buildings, land, machinery, etc.
- Assets can be tangible or intangible. Tangible assets are assets that have physical existence and can be seen and touched. Tangible assets are also called physical assets. Typical examples of tangible assets are buildings, machines, cash, office supply, etc. Intangible assets are assets that do not have physical existence and typical examples are digital assets, intellectual property, knowledge, etc.

- With regards to their business operation usage assets can be operating and non-operating. Operating assets are asset that are used during daily operations and generate cash. Typical examples of operating assets are cash, building, machinery, equipment, etc. Non-Operating assets are assets that usually generate income but are not used daily. Examples of non-operating assets are vacant land, spare parts, long term investments, etc.

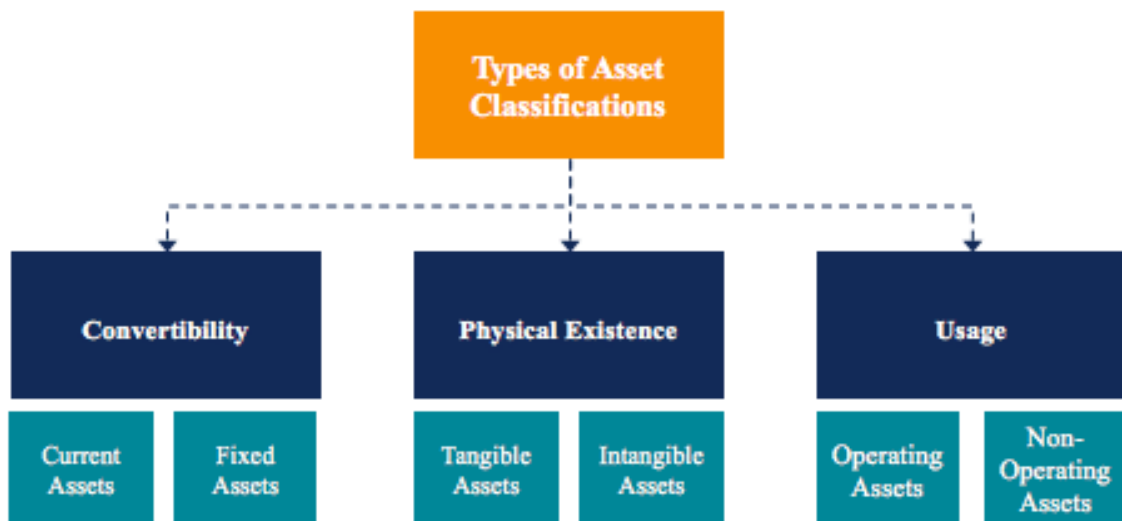


Figure 2 Classification of assets (corporatefinanceinstitute.com, n.d.)

2.2 Physical Assets

Physical assets are tangible assets that have physical existence and can be seen and touched. As it is defined in ISO 55000 (2014, p.13), physical assets usually refer to equipment, inventory and properties owned by the organization. Amadi-Echendu (2010, p.348) highlights that, from an accounting and financial management point-of-view, physical assets generally fall into four broad categories – (i) plant and equipment, (ii) buildings and infrastructure, (iii) furniture and fittings, and (iv) information technology. Most organizations heavily rely on their physical assets: buildings are needed to accommodate employees and equipment; machinery is needed to ensure delivery of the products and services. In fact, “in many organizations, physical assets are the foundation for success and future growth” (Frolov, et al., 2010, p.20).

Amadi-Echendu (2010, p. 348), highlights that the life-cycle of a physical asset goes through 4 phases from creation to utilization. Need for an asset initiates the creation phase. During creation phase the concept of the asset will be developed, feasibility will be confirmed, and engineering activities will be conducted. Establishment phase consists of procurement of the components, construction and commissioning of the assembly. During exploitation phase assets will be operating and will be maintained. The last phase of the asset lifecycle is the termination and disposal of the asset.

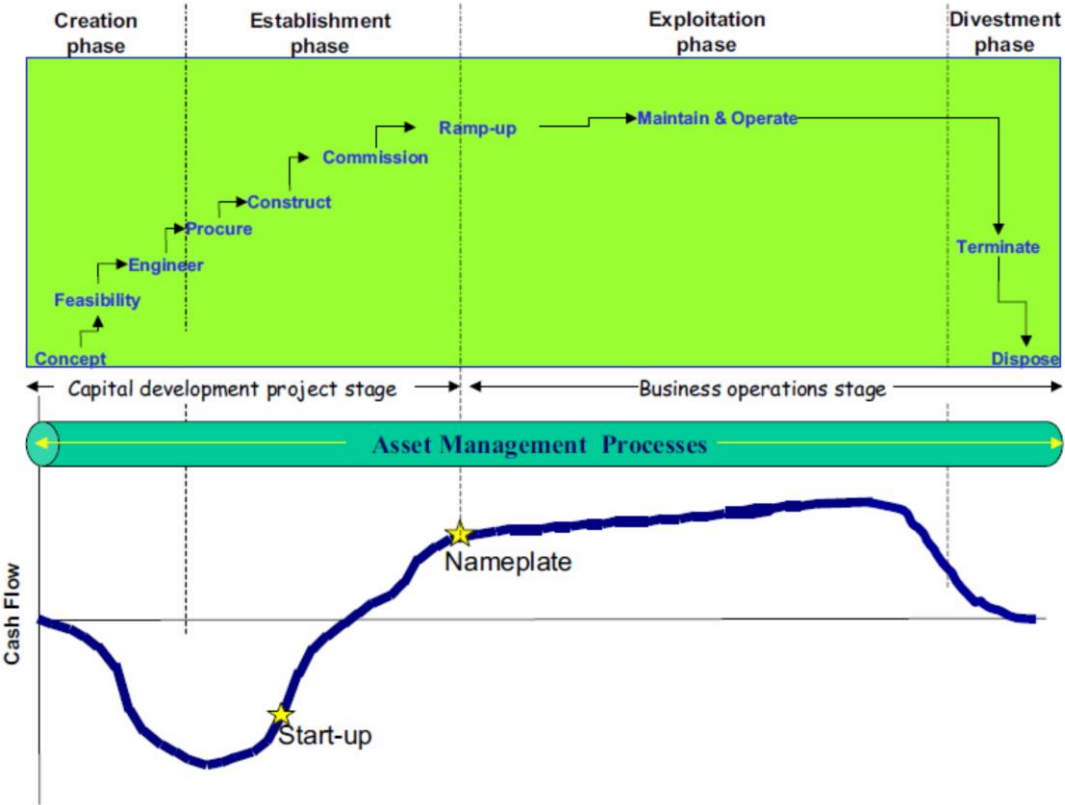


Figure 3 Life-cycle stages and phases of physical assets (Amadi-Echendu, 2010. p.348)

IAM (2015, p.12), on the other hand, highlights that the naming and number of the asset life cycle stages, and activities under each stage, can vary in different industry sectors. By looking at Figure 4 one can see that IAM (2015, p13) promotes a common principle where the life cycle of an asset includes all aspects of managing assets from the initial concept through the disposal.

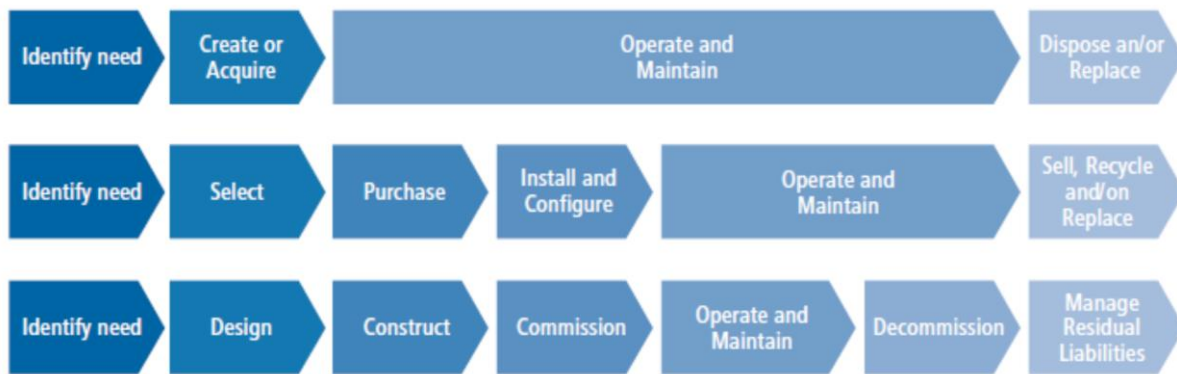


Figure 4 Examples of variations in the description of asset life cycle stages (IAM, 2015, p.13)

2.3 Digital Asset

The era of practical application of digital solutions started in 1940s, when SIGSALY secure speech system was utilized during World War II for the first digital voice transmission. In accordance with Press (2015), already in 2007, 94% of the world's information storage capacity was digital, a complete reversal from 1986, when 99.2% of all storage capacity was analog. It has been acknowledged by the world-wide industry that the key to competitive advantage is not the wealth, but it is ability to utilize knowledge. Introduction of the cloud technologies, big data and analytics, artificial intelligence made the data and knowledge to be asset to every organization – a digital asset.

Internet is full of definitions for digital asset. Summary of all those definitions is that anything that has a value to a person or an organization, comes with the right to use and is in digital format is a digital asset.

- Range of assets that can be classified as digital assets is broad and may include:
- Media files, such as photos, videos and music
- Documents, book and other types of text material and information
- Intellectual assets, such as patents, copyrights, trade secrets
- Data and information that is in digital format
- Cryptocurrencies

Digital assets are the type of intangible assets. They are stored on electrical devices such as mobile phones, computers, servers and so on. The data generated from content created by an

organization to data collected from sensors inside machines sold to consumers are digital assets that generate value to the organizations (Raschke and Mann, 2017).

Diamond (2012, page 11) compares a physical asset (a truck) management to digital (a file) asset management:

Physical Asset Management	Digital Asset Management
Where is the truck now?	Where is the file now?
When was the truck last serviced, and who performed that service?	When was the file last edited, and who edited that file?
When is the truck due for maintenance?	When will the file need to be updated?
Who is authorized to perform maintenance on the truck?	Who can edit the file?
Who must approve the maintenance before the truck is returned to service?	Who must approve the edits before the file can be released?
When is the truck due for registration?	When will file's license expire?
How does the truck contribute to the company's bottom line?	How does the truck contribute to the company's bottom line?

Table 2 Comparison of physical asset management with digital asset management (Diamond, 2012, page 11)

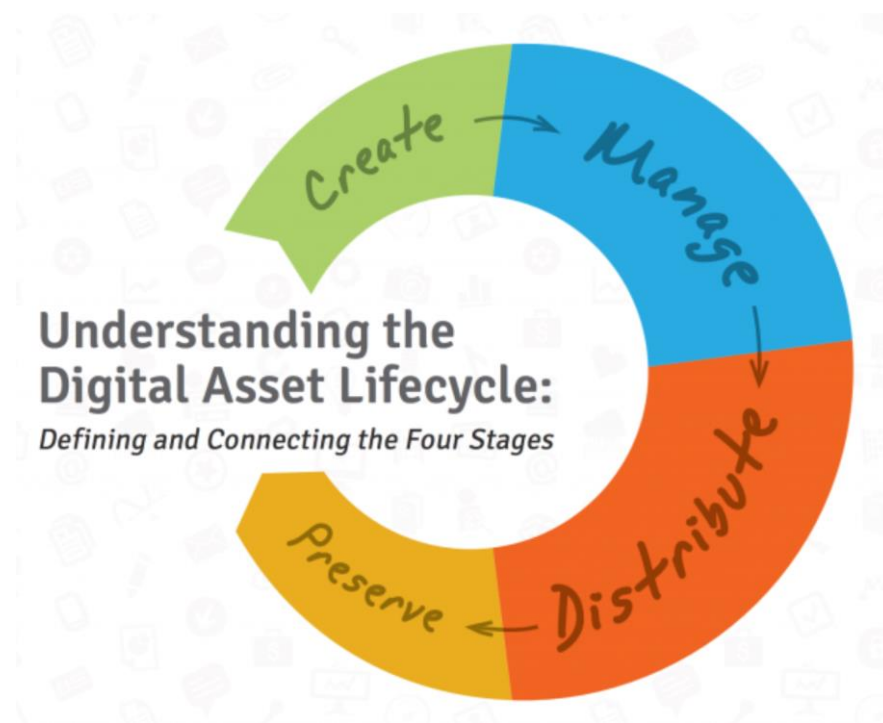


Figure 5 Four stages of a digital asset (digitalassetmanagement.com, 2015)

In accordance with Digitalassetmanagement.com (2015), lifecycle of a digital asset goes through 4 stages:

- Creation where organization defines need for assets, generates ideas, for example, about the content of the digital asset, plans timelines and develops assets. For example, when an organization develops new products or services, it needs to define what kind of digital assets, such as design drawings, 3D models and operational documents, will be produced; agree about content and the structure of the documents, layout of the drawings and 3D models; define timelines that are in accordance with project needs; and start producing assets.
- Management where the quality of the digital asset needs to be verified and asset released for use
- Distribution is when assets are finally uploaded to the tools and systems so the whole organization can be accessing the assets.
- Preservation when asset is being kept in the database for future use and revision.

It is important to highlight that, the relevancy of the lifecycle definition on Figure 5 may be limited to media files such as photo and video files, 2D and 3D models, and documents.

2.4 Digital IP Assets

Intellectual property is another type of intangible assets. “It is called intellectual property because it is the product of human creativity, thought, and inventiveness. Although much of intellectual property is intangible, it can be more valuable than real or personal property” (Bouchoux, 2006, p.1). Nowadays most of the intellectual property is being stored in a digital format. Therefore, intellectual property can be categorized as a digital IP (intellectual property) asset.

Bouchoux (2006) and Halligan and Weyand (2018) identify four types of intellectual property:

- Copyrights, that defend novelty of the work such as literature, music and art.
- Trademarks, that distinguishes companies’ products or services with logos, designs, slogans or other type of unique identification methods.
- Patents, that entitles the owner of an invention to exclude any person or entity to from making, using, selling and offering to sell the invented product for a limited time.
- Trade Secrets, that provides a competitive advantage to a person or entity due to specific and classified knowledge of a business specific information such as databases, formulas, processes, design details and so on.

Trade secrets are the most interesting type of digital IP assets for the scope of this thesis. In accordance with Halligan and Weyand (2018), “trade secret” means information, including a formula, pattern, compilation, program, device, method, technique, or process, that:

- (i) derives independent economic value, actual or potential, from not being generally known to, and not being readily ascertainable by proper means by, other persons who can obtain economic value from its disclosure or use and (ii) is subject of efforts that are reasonable under circumstances to maintain its secrecy.

Table 3 provides a comparison of the two most common type of digital IP assets which are patents and trade secrets.

	Patents	Trade Secrets
Coverage	Inventions	Any Information
Requirements	Novel, useful, non-obvious	Competitive advantage from being secret, measures taken to maintain secrecy
Examination	By government examiner	None
Disclosure	On application	Never
Term	20 years	Indefinite
Public Domain	On expiration	Never
Costs	Application & attorney fees	Cost of maintaining secrecy
Reverse Engineering	Prohibited	Allowed
Independent Development	Prohibited	Allowed

Table 3 The differences between patents and trade secrets (Halligan and Weyand, 2018, Kindle book location 204)

Digital intellectual property assets such as trade secrets have an important role throughout the whole lifecycle of physical assets. With reference to Figure 3 that shows life-cycle stages and phases of physical assets, trade secrets are needed at every stage:

- Design practices, bill of materials and list of vendors will be needed to engineer and procure the components of the physical assets;
- Production, manufacturing, testing and commissioning procedures will be needed to complete the establishment phase;
- In exploitation phase operational processes, procedures and maintenance programs will be needed to ensure that physical assets function and provide value to the organizations as expected;
- Finally, divestment phase will require necessary procedures and processes to ensure that physical assets are effectively and safely, without any harm to environment, have been disposed.

3 Asset Management

Liyanage (2012, p.15), Hastings (2014, p.4) and Too (2010, p.59) highlight that there are several alternative definitions of asset management. It seems like various asset management organizations and professionals tend to stick to their definitions.

However, all those definitions have a common ground:

- Asset management is a coordinated activity of an organization to realize value from assets (ISO 55000, 2014, p.14)

3.1 History and Development of Asset Management

Humans have always owned valuable things such as land, buildings, equipment, gold, currencies and so on. Those valuable things have always been managed in one way or another.

Edwards (2010, p.5) highlights that it is difficult to pinpoint the origins of the asset management term, and it is a relatively new description of activities that have been undertaken for many decades but previously in a more fragmented way. Pilling (2010, p.76) has an opinion that asset management has evolved over many decades, and has learned from and incorporated other disciplines and techniques. What is clear is that the development of asset management practices was catalyzed by industrial progress and constant need to improve safety, sustainability, operational processes and financial results. This was paramount for gaining competitive advantage in the markets that were becoming rapidly dynamic. Defining equipment maintenance as asset management was not acceptable anymore. It was necessary to develop practices where asset management would be part of a long-term strategy. Asset management, as argued by Lloyd (2010, p. xiii), needs to be a strategic discipline which gives rigor and accountability to the way organizations decide:

- How, where and what to invest;
- What assets are most critical;
- What risks need to be managed;
- What demands must be served;
- What needs to be known;

- How this knowledge should be captured and disseminated;
- How organizations should be structured and led;
- What types and teams of people they need;
- How activities should be carried out;
- How actual performance should be measured;
- Which improvements are required.

Asset management involves bringing these and many other decisions into a coherent framework to ensure their outputs serve organizational goals

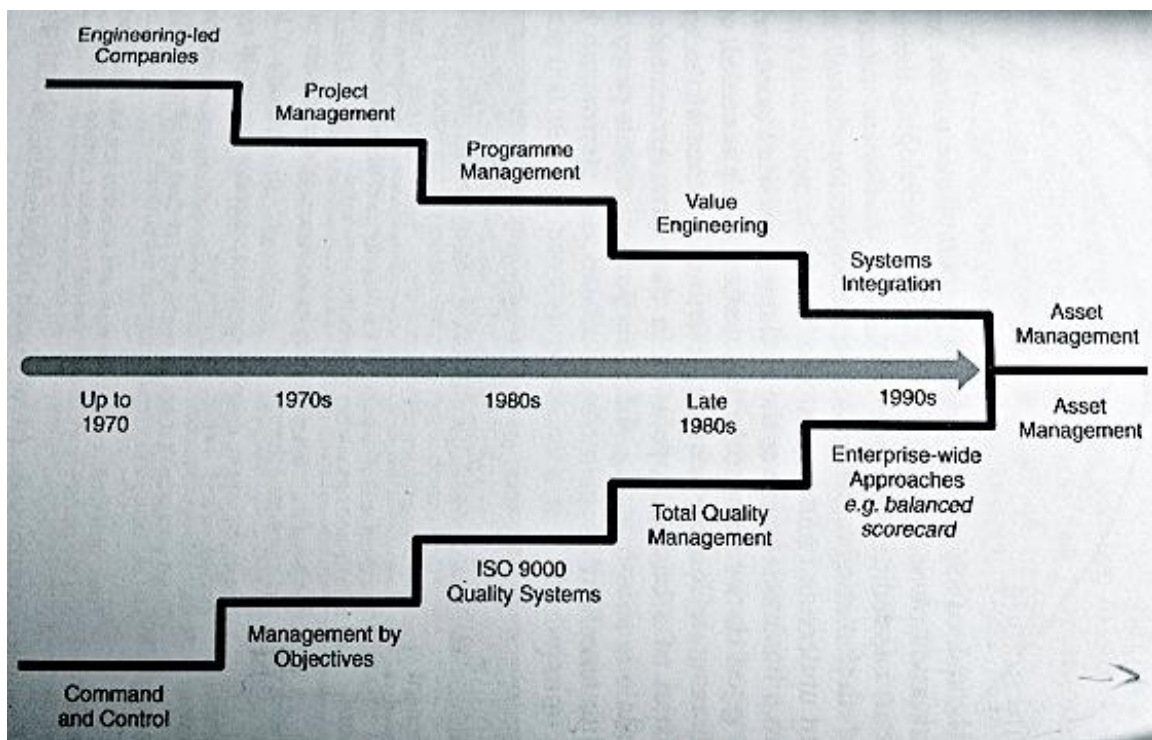


Figure 6 The evolution of asset management (Pilling, 2010, p.77)

In 2008, first Publicly Available Specification (PAS 55) for physical asset management was published by the British Standards Institution (BSI) in cooperation with 49 organizations from 15 industries in 10 countries. “It has been very widely adopted around the world, with great success as a tool for integrating and improving business practices, raising performance and assuring greater consistency and transparency” (Woodhouse, 2014). The reaction to PAS 55 was very positive, and many companies started adjusting their asset management practices in accordance with the requirements and guidelines of this specification. This kind of positive

reception led to the development and publishing of the first international asset management standard, ISO 55000 suite, in 2014. Different from PAS 55, ISO 55000 suite could be applied to all types of assets and by all types and sizes of organizations. ISO 55000 suite brings benefits in an age where money, physical assets and reputation are no longer the main success factors. As it is highlighted by Mentzas, et al. (2003, p. 1), success will be essentially determined by our ability to use knowledge. Nowadays knowledge is trade secrets, data that is generated by equipment, market information and other kinds of information that provides a competitive advantage.

3.2 Asset Management Fundamentals

In accordance with ISO 55000 (2014, p. 3), the fundamentals of asset management consist of Value, Alignment, Leadership and Assurance.

Value

Assets are tools for creating, providing and increasing value to organizations and their stakeholders. Asset management discipline does not concentrate on the assets themselves, but rather on how the assets can contribute to value creation. The value from the assets needs to be realized by:

- using of a lifecycle management approach;
- clearly stating how the asset management objectives will be and are aligned with the organization objectives;
- establishing and utilizing decision making processes that consider stakeholder needs and expectations;

Alignment

Asset management translates organizational objectives into asset-related financial and technical decisions and asset related plans and activities by:

- utilizing risk-based and information-driven planning and decision-making activities;
- integrating the asset management processes with all management processes of the organization;
- implementing and using an asset management system.

Leadership

Leadership and workplace culture have a direct impact on the value realization.

To successfully establish, operate and improve the asset management in an organization, commitment will be required by leadership, managers and employees of the organization.

Leadership and the management of the organization will need to ensure that:

- roles, responsibilities and authorities involved in asset management are clearly defined;
- employees are aware of and empowered to competently contribute to the asset management initiatives;
- stakeholders are consulted with regards to the changes and initiatives in asset management practices in the organization.

Assurance

Asset management will ensure that organization's assets effectively contribute to the value creation and fulfill their purpose. To do so, organizations need to:

- develop and implement processes that connect the specified goals and performance of the assets to the organizational objectives;
- implement processes so asset capability, across all life cycle stages, can be assured;
- implement processes for monitoring and continual improvement;
- provide the necessary resources and competent personnel so the asset management activities can be performed, and asset management system can be operated.

3.3 Conceptual Models for Asset Management

The understanding of the asset management concept and the way how it is applied may differ due to several factors such as maturity, the operational context, stakeholder expectations, etc. However, organizations should integrate four fundamentals that are described in ISO 55000 (2014, p. 3) into their organizational processes.

The members of Global Forum on Maintenance and Asset Management (GFMAM) have created several conceptual models for asset management. These conceptual models are based on fundamentals that are described in ISO 55000 (2014). GFMAM is a forum that promotes

and develops knowledge, standards and education for maintenance and asset management professionals. The forum has members that each represent asset management institutes and associations in 8 regions of the world (GFMAM presentation, n.d.), such as The Asset Management Council, The Institute of Asset Management and The European Federation of National Maintenance Societies.

Asset Management Conceptual Model by The Asset Management Council

The Asset Management Council is an internationally recognized organization at the forefront of asset management knowledge and development, that provides information and guidance on asset management across a multitude of industries and professional roles, both in Australia and overseas (amcouncil.com.au, n.d.). The Asset Management Council (2017) has developed an Asset Management Concept Model that incorporates all four elements of the asset management fundamentals into a Plan, Do, Check, Act (PDCA) learning and improvement cycle. The information about the model was taken from the presentation that is available on amcouncil.com.au. Unfortunately, the practical applicability of the concept was not discussed in the presentation. The model is shown in Figure 3 and is based on the principles of:

- Output Focus, where “What is your asset to be used for” question needs to be answered, to have a complete understanding of asset application and all risks and opportunities that are deriving from this application;
- Capabilities, where an organization needs to understand not only the actual value that is provided by an asset to the organization but also the capabilities and intrinsic value of the asset that can contribute to the organization beyond assets specified performance;
- Level of Assurance, where the organization needs to understand the likelihood of the asset to fail and not to perform in accordance with expectations. The Asset Management Council (2017, p.7) highlights that all various types of risks that can affect the output of the asset need to be considered. Once the effect on the output is understood, the organization will need to balance the cost, opportunities and risks against the desired performance of the assets;
- Learning Organization, where the organization creates a “learning organization” culture and employees “[...] are always looking for a way to improve productivity, streamline a procedure or increase the value of the product they are producing [...]” (The Asset Management Council, 2017, p.8)

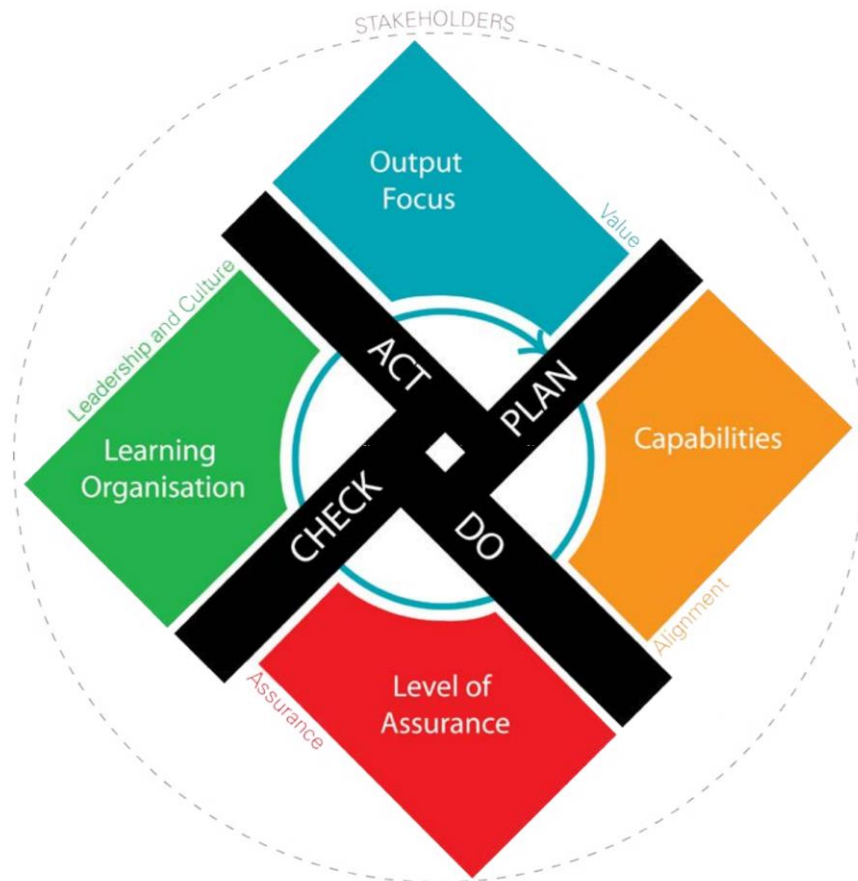


Figure 7 Asset management conceptual model by the Asset Management Council (2017)

Asset Management Model by The Institute of Asset Management

The Institute of Asset Management is the international professional body for asset management specialists. The IAM develops asset management knowledge and best practice and generates awareness of the benefits of the discipline for the individuals, organizations and wider society (theiam.org, n.d.). The IAM has developed an Asset Management Model that is based on six subject groups that cover 39 asset management subjects. Figures 8 and 9 show the model and the alignment between asset management subjects and groups. In accordance with IAM (2016, p.17), the subjects were developed in recognition that an asset management system standard would identify what is required to be in place for the management, but would not address how asset management could be implemented. Considering that IAM (2015, p. 82) shows how each of the subjects in the conceptual model corresponds to specific clauses in ISO 55001, one can conclude that the concept is aligned with fundamentals of the asset management that are described in ISO 55000. IAM (2015, p. 24) promotes a holistic and

integrative approach to asset management which is in accordance with the definition of the asset management in ISO 55000.

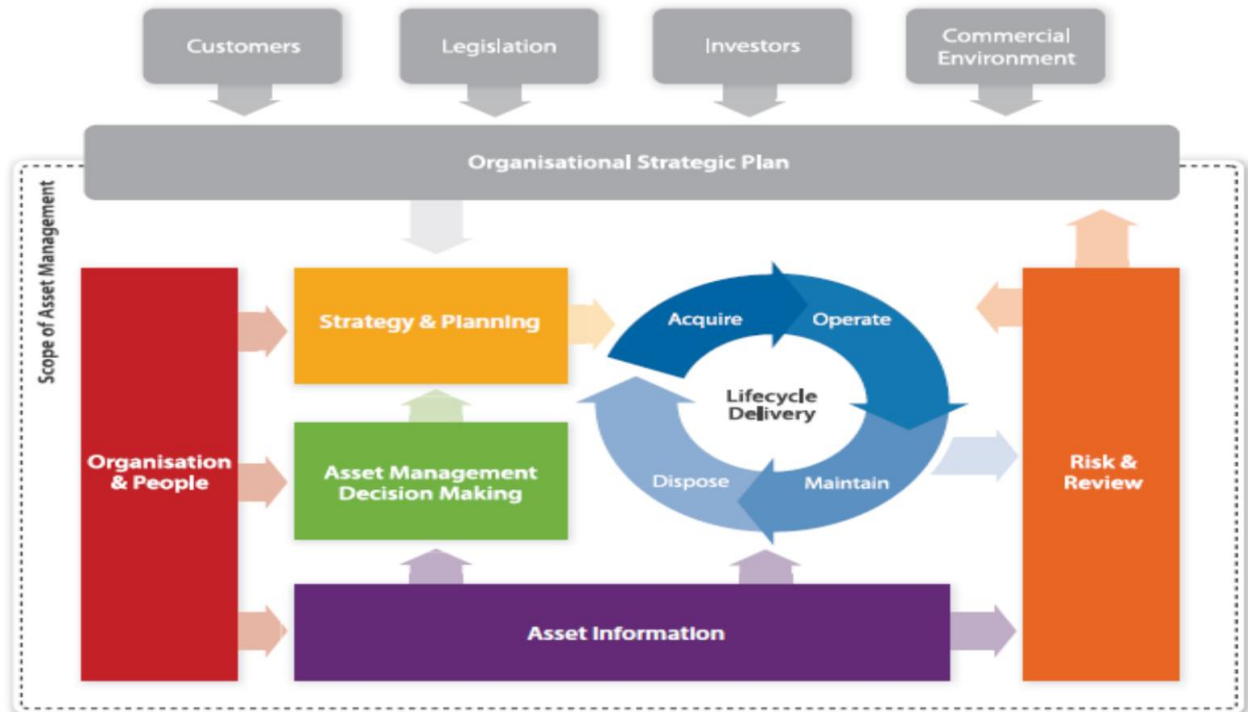


Figure 8 Asset management conceptual model by IAM (2015, p.16)

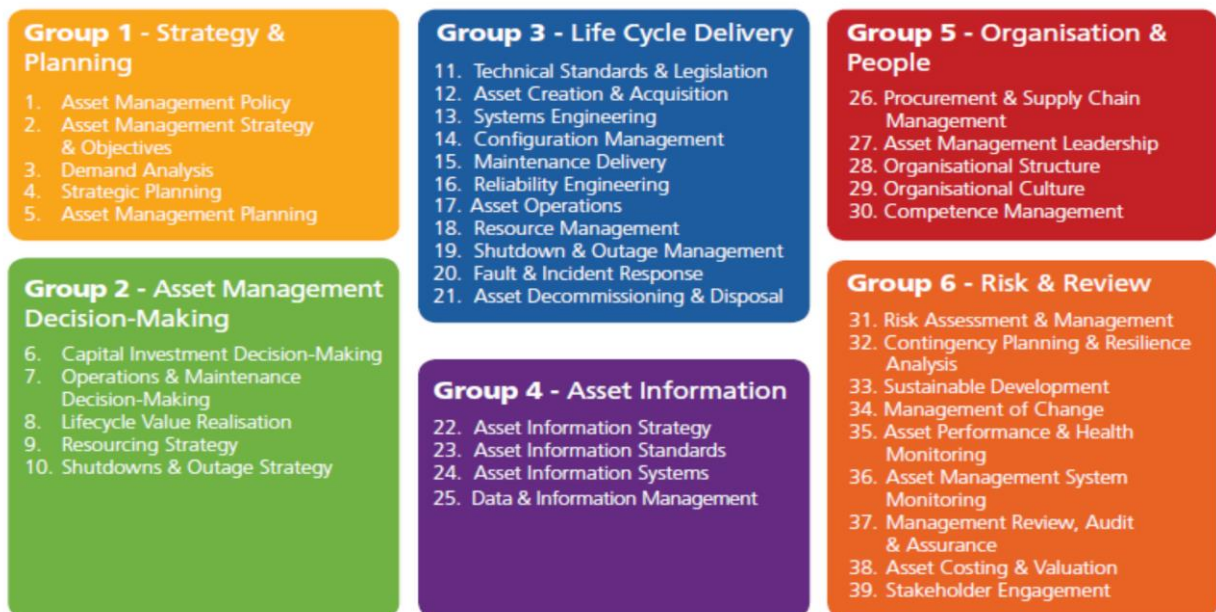


Figure 9 Alignment of 39 asset management subjects with the six subject groups (IAM, 2015, p.17)

3.4 Benefits of Asset Management

As it is highlighted in ISO 55000 (2014, p.2) benefits of asset management can include, but are not limited to:

- improved financial performance due to improved return on investments and reduced costs;
- informed asset investment decisions: due to improved decision-making processes as an outcome of effectively balanced costs, risks, opportunities and performance;
- managed risk: can result in reduced liabilities such as insurance premiums, fines and penalties due to minimized environmental and social impact, improved health and safety, goodwill and reputation;
- enhanced services and outputs due to assurance of the asset performance and exceeded expectations of customers and stakeholders;
- demonstrated social responsibility due to ability, for example, to reduce emissions, conserve resources and adapt to climate change
- demonstrated compliance: adhering to asset management standards, policies and processes, can enable demonstration of compliance;
- enhanced reputation: through improved customer satisfaction, stakeholder awareness and confidence;
- improved organizational sustainability due to effective management of short and long-term effects, expenditures and performances;
- improved efficiency and effectiveness due to continuously reviewing and improving processes, procedure.

3.5 Asset Management Systems and ISO 55000

ISO 55000 suite is the first set of ISO standards that is covering the subject of asset management. The suite consists of 3 documents:

- ISO 55000 that provides an overview of asset management, its principles and terminology and discusses the benefits of asset management.
- ISO 55001 that sets requirements to an asset management system
- ISO 55002 that guides design and operation of an asset management system by reflecting the requirements in ISO 55001

ISO 55000 (2014, p.15) explains the term asset management system as a “management system for asset management whose function is to establish the asset management policy and asset management objectives.” ISO 55000 (2014, 0.4) also highlights that “an asset management system is a set of interrelated and interacting elements of an organization, whose function is to establish the asset management policy and asset management objectives, and the processes, needed to achieve those objectives.”

Figure 10 shows the relationship between asset management and asset management system. One can see that an asset management system is an element of asset management, with an asset portfolio in the core. It is important to mention that aspects such as the management commitment, ability to empower and motivate employees and organizational culture are part of the asset management activities and have a significant impact on the outcomes of the asset management. However, as it is highlighted by Gulliksen (2017, p. 36) these aspects have abstract nature, have deeper roots in the organization and cannot be established or improved by an asset management system only. This idea is also highlighted in ISO 55000 (2014, p.4) and reflected in Figure 10 by setting organizational management on the top of everything.

ISO 55000 suite is created for managing any kind of assets by any type of organization. However, the suit specifies that it has been created for managing physical assets mainly. It is the goal of this thesis to evaluate the application of ISO 55000 suite for managing intangible assets such as digital assets.

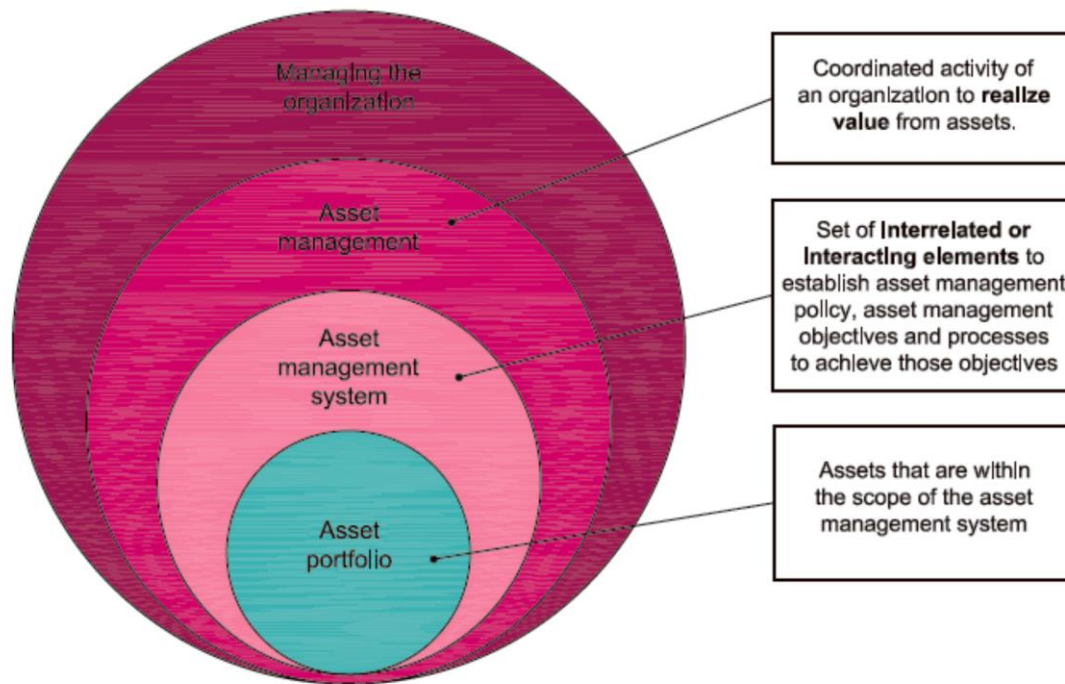


Figure 10 Relationships between key terms of asset management (ISO 55000, 2014, p.4)

3.5.1 Elements of Asset Management System

The asset management system that is described in ISO 55000 has seven main elements that are divided into 24 clauses. The main seven elements cover the following areas:

- Defining the context of the organization;
- Leadership commitment and strategy, including policies and roles and responsibilities;
- Planning for asset, asset management and asset management system related activities;
- Supporting effective asset management and asset management system by introducing and managing necessary resources, tools and information;
- Operational control of the asset management system;
- Performance evaluation of the asset, asset management system and other supporting resources and tools;
- Continuous improvement of the asset management system

The relationship between the key elements and all clauses in a Plan, Do, Check, Act model are shown in Figure 11. 24 clauses of the ISO 5500 are discussed in detail in the next chapters.

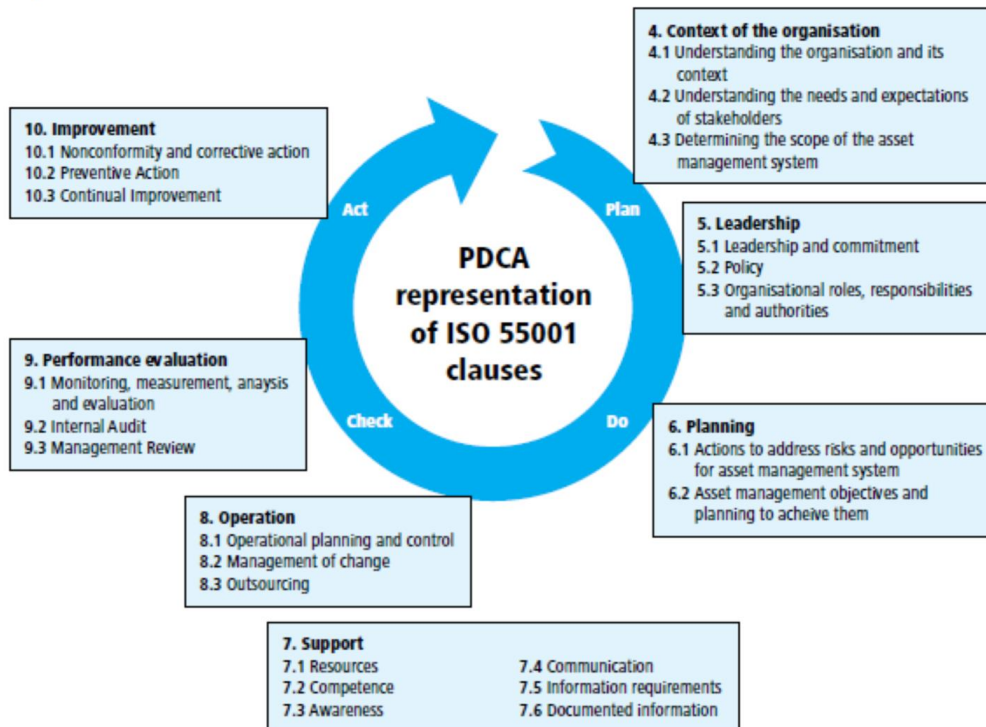


Figure 11 Elements of asset management system and Plan-Do-Check-Act model (IAM, 2015, p.25)

IAM (2015, p.26) provides this PDCA model as an example and highlights that an organization can choose different methods, for example, Lean and Six Sigma, for adaptation of the asset management system.

As it has been highlighted by ISO 55001 (2014, p. V), the order in which the requirements presented do not reflect their importance or imply the order in which they need to be implemented.

3.5.1.1 Context of the Organization

Understanding the organization and its context

Before an organization introduces an asset management system it is important to ensure that all external and internal issues related to purpose of the system are identified and reviewed. As a part of the review process, organization needs to understand how those external and internal issues can affect purpose and performance of the assets and the management system for those assets.

For an organization that manages digital assets, internal issues might be, but not limited to:

- Organizational objectives and strategy;
- Overall asset management policy of the company;
- Expectations of the internal stakeholders, such as top management, users and other functions of the organization that are dependent on the performance of the digital assets;
- Interfaces with other management systems;
- Availability and capability of the IT systems with regards to the operations, safety, access control, etc.;
- Any observed and registered “lessons learned” and experiences from asset management in the organization;
- Digital asset management culture of the organization.
- External issues with regards to the digital asset management might be, but not limited to:
 - Possibility of cyber-attacks;
 - Situation in the global IT landscape with regards to the regulations and technological development;
 - Interfaces with external organizations, such as third parties, vendors, auditors, etc.

Understanding the needs and expectations of stakeholders

ISO 55000 (2014, p.12) defines a stakeholder as “person or organization that can affect, be affected by, or perceive themselves to be affected by a decision or activity¹”. In general, each organization will have:

- Internal stakeholders, such as shareholders, management, employees;
- External stakeholders, such as clients, government and non-government organizations, vendors, etc.

The perception of the external stakeholders, such as clients, have a significant impact on the reputation of the organization. Although clients might now have direct contact with the most digital assets that belong to the organization, quality of the products and services that are delivered to client are directly affected by the quality of the organization’s digital assets that are part of engineering and manufacturing processes. Wrong input from the engineering documentation and manufacturing processes will have a negative impact on the performance of the final product. Moreover, wrong manufacturing procedures may create hazards to the organization’s employees that are directly involved in the manufacturing and testing processes.

Therefore, it is important to communicate with stakeholders; understand, gather and document their requirements and expectations; measure satisfaction of both internal and external stakeholders with the level of the service that is being delivered. Stakeholder expectations need to be reflected in the SAMP. By doing so, organization ensures that all asset management related activities that are planned consider stakeholder expectations and satisfaction.

Determining the Scope of the Asset Management System

When context of the organization and stakeholder expectations are understood, boundaries and the scope of the digital asset management system will need to be set and documented. The scope of the asset management system will need to consider:

- Digital asset portfolio and digital asset lifecycle related issues, such as creation, management, distribution and preservation.

¹ Decision or activity related to digital assets, in this case.

- Interaction with the internal and external stakeholders that can affect the performance of the digital assets and digital asset management system.
- Integration with the systems of the internal and external stakeholders, as necessary

Asset Management System

As a part of digital asset management activities, organization shall establish, implement, maintain and continually improve a digital asset management system. An asset management policy will need to be a start point in establishing the digital asset management system. Further on, a SAMP, describing the role of the asset management system in achieving asset management objectives, will need to be developed. The SAMP will need to consider all assets of the organization, including digital assets.

3.5.1.2 Leadership

Leadership and commitment

ISO 55002 (2014, p.6) highlights that ownership and accountability for asset management remains at the top management level. Top management of the organization and leadership shall ensure that the asset management policy, the SAMP and asset management objectives are in place and are reflecting organizational objectives. Top management and leadership shall ensure that the organization is compliant with requirements of ISO 55001 and asset management system achieves its goals. Top management and leadership will need to provide necessary resources to ensure that asset management system functions in accordance with expectations. Top management and leadership needs to constantly empower and motivate the organizations towards continuously improving asset management practices. As it has been mentioned in chapter 3.5, leadership and commitment cannot be established or improved by an asset management system only, since these aspects have abstract nature and have deeper roots in the organization. Therefore the top management of the organization needs to promote and support asset management culture in the organization.

Policy

The asset management policy is a short statement that sets out the principles by which the organization intends to apply asset management to achieve its organizational objectives (ISO 55002, 2014, p.7). It is responsibility of the top management to establish and update, as

necessary, an asset management policy that is aligned with organizational purpose, plans and management systems and provides asset management objectives. Asset management policy shall be documented, communicated promptly and easily available for all stakeholders, as appropriate.

Organizational roles, responsibilities and authorities

Top management and leadership of the organization shall ensure that all roles, responsibilities and authorities within the scope of the asset management are defined, documented and their competence is continuously evaluated and updated. This is relevant both for internal and outsourced departments.

3.5.1.3 Planning

Actions to address risks and opportunities for the asset management system

Asset management involves the balancing of costs, opportunities and risks against the desired performance of assets, to achieve the organizational objectives (ISO 55000, 2014, p.3). When establishing, operating, maintaining and modifying the asset management system, organization shall identify and review the risks and opportunities that are relevant to objectives of the organization and expectations of the stakeholders. The risk and opportunity management approach shall be aligned with organizational risk and opportunity management practices, with appropriate level of mitigation, control and monitoring in place. Risks can be direct asset related, such as failure, health, safety, environment and indirect asset related, such as competence, processes, resources, etc.

Asset management objectives and planning to achieve them

Organization shall establish the asset management objectives. Asset management objectives need to be aligned with organizational objectives and strategies. These objectives should be examined and converted into objectives of each group or sub-organization that is involved in the asset management activities. When establishing its asset management objectives, the organization shall consider the requirements of relevant stakeholders and of other financial, technical, legal, regulatory and organizational requirements in the asset management planning process (ISO 55001, 2014, 4). It is important to ensure that asset management objectives are measurable and can be monitored to ensure that objectives are being reached. There shall be

specific plans for achieving the asset management objectives. These plans shall be aligned with asset management policy and the SAMP.

3.5.1.4 Support

Resources

The need for resources involved in the establishing, implementing, maintaining and continual improving of the asset management system should be identified already in the early stages of the asset management system development. Identification process will need to consider both human and technological resources and should be executed in a form of a gap analysis against available resources in the organization. Gap analysis will provide an insight to organization with regards to the resources that are needed for meeting the objectives of the asset management and for implementing the activities specified in the asset management plans.

Once asset management plans are reflected in the SAMP, organization shall ensure that it has necessary resources to implement these plans.

Resources can be internal or external, such as vendors, third parties, etc. Resources can be financial, equipment, employees, processes and systems, etc.

Competence

ISO 55000 (2014, p. 10) defines competence as ability to apply knowledge and skills to achieve intended results. Organization needs to identify the knowledge and skills that are needed to ensure performance of the assets, asset management and asset management system. Personnel shall have necessary training, education and experience related to the organization's assets portfolio, asset management practices and asset management systems. All competence will need to be documented and reviewed periodically for ensuring that future competency needs, and requirements are understood, and necessary actions for providing the competency are planned.

Awareness

Personnel, direct and indirect involvement in the asset management, and any other external parties engaged in the asset management activities for the organization shall be aware of the organization's asset management policy. Everyone need to be aware of their contribution to

the performance of the asset management system. Personnel of the company needs to have a clear understanding about the possible negative outcomes if their actions are not in conformance with the asset management system requirements. Awareness can be raised through development of focused and positive asset management culture, introduction of processes and systems, dedicated training, communication and presentations for internal and external parties.

Communication

Asset, asset management and asset management system relevant information shall be communicated to external and internal parties and stakeholders. Organization shall define:

- On what it will communicate;
- When to communicate;
- With whom to communicate;
- How to communicate.
- Information requirements

The organization shall determine its information requirements to support its assets, asset management, asset management system and the achievement of its organizational objectives (ISO 55001, p.6). Organization should proactively identify asset information that needs to be gathered, analyzed and stored, in order to have a good understanding of asset health, condition, performance, costs, etc. The information can be:

- Assets related strategy and planning;
- Performance of the asset related processes;
- Asset technical information;
- Asset performance information;
- Asset maintenance related information;
- etc.

The need for the information will be dependent on the organization and the asset type.

Documented information

Organization will need to determine the type of the asset relevant information that needs to be documented. Documentation of information can be used for showing compliance with the stakeholder requirements and requirements of ISO 55001. In addition, documented information can be utilized for continuous monitoring and improvement of asset, asset

management and asset management system performance with regards to all relevant factors such as, cost, downtime and so on. Relevant control mechanisms for ensuring access, creation, modification and distribution of documented information should be established.

3.5.1.5 Operation

Operational planning and control

Organization shall plan, implement and control the processes that are needed for:

- Managing risks and opportunities for asset, asset management and asset management system;
- Delivery of the activities in the asset management plans;
- Continuous improvement.

It is important to ensure that processes mentioned above have sufficient support in the form of resources and competence. In order to ensure that processes are performing effectively, organization can introduce KPIs, audits and other type of process quality and performance assurance and improvement measures.

Management of change

Organization shall have necessary management of change processes. These processes shall control and mitigate the risks that can be introduced due to changes to the assets, asset management practices and asset management system. Other type of changes can be related, but not limited to:

- External, such as markets, client, supply chain;
- Internal, such as organizational, human resources, processes and systems.
- All identified risks shall be assessed and managed in accordance with organization's risk management activities.

Outsourcing

When the organization outsources any activities that can have an impact on the achievement of its asset management objectives, it shall assess the associated risks (ISO 55001, p.8). In order to control the risks associated with outsourcing, organization shall implement processes for controlling the performance of the outsourced activities. This can be done by:

- Raising an awareness of the way how outsourced activities may affect the organization's objectives, as well as asset management objectives;
- Defining clear roles and responsibilities with regards to control of outsourced activities;
- Introducing and maintaining two-way communication channels for sharing information, requirements, knowledge and so on.

When outsourcing any life cycle activities and asset management activities, the organization should consider the risks and impacts on its assets, asset management and asset management system (ISO 55002, p.20). Organization will need to measure and control the performance of the asset management related outsourced activities and processes.

3.5.1.6 Performance Evaluation

Monitoring, measurement, analysis and evaluation

In order to ensure that organization's asset management objectives are met, organization shall determine the performance parameters that need to be monitored, measured, analyzed and evaluated. All necessary processes to support these activities shall be established.

Organization shall determine the timelines and methods that will be used for establishing these processes. Organization will need to evaluate and report the effectiveness of the processes that are being monitored, measured, analyzed and evaluated. All results shall be documented.

Internal audit

To ensure effectiveness and integrity of the assets, asset management processes and asset management system, organization shall conduct audits. Audits should be both internal in the organization and external for outsourced activities. The audits shall verify that the organization conforms to internal requirements and processes, as well as requirements of ISO 55001.

Management review

It is important that the management of the organization periodically reviews the performance of the organization's assets, asset management processes and asset management system. The review process shall:

- Revisit the results of the last review process and control the status of actions;
- By utilizing the management of change processes, consider impact of the internal and external changes on the assets, asset management processes and asset management system.

The output of the management review shall initiate continual improvement activities. The results of the management review shall be documented for future references.

3.5.1.7 Improvement

Nonconformity and corrective action

Organization shall react to incidents and nonconformities in its' assets, asset management and asset management system by taking control of the nonconformity and incidents, and deal with the outcomes. Organization shall do everything possible to ensure that the causes of the nonconformity and incidents are identified. In addition, it shall be ensured that similar type of incidents do not occur. All nonconformities, corrective actions and the results of corrective actions shall be documented. Corrective actions are actions taken to address the root cause(s) of identified non-conformances, or incidents, in order to manage their consequences, and to prevent or reduce the likelihood of recurrence (ISO 55002, 2014, p.26).

Preventive action

Preventive actions, which may include predictive actions, are those taken to address the root cause(s) of potential failures or incidents, as a proactive measure, before such incidents occur (ISO 55001, 2014, p.26). Organization shall have processes for proactive identification of failures in assets, asset management practices and asset management systems. When failures are identified, organization shall utilize established processes for initiating preventive and predictive actions.

Continual improvement

The organization shall continually improve the suitability, adequacy and effectiveness of its asset management and the asset management system (ISO 55001, 2014, p.11). By utilizing monitoring and corrective actions, organization should identify, assess and implement corrective and improvement actions for the assets, asset management and asset management system. Efforts towards continual improvement should be a top-down and down-top process. In addition to continual nonconformity handling, and asset related corrective and preventive actions, organization should be up-to-date with regards to the new technologies that can improve performance of the assets, asset management and asset management system.

3.6 Digital Asset Management

A search for “management of digital assets” and “digital asset management” in google brings millions of results. Checking every link for relevancy is impossible. However, most of the links forward to the pages that talk about digital asset and content management. Digital asset management is a big industry that consists of many vendors that provide various digital asset management software. The industry calls digital asset management solutions as a DAM (Digital Asset Management). Definition of digital asset management vary from one source to another:

- Damglossary.org (n.d.) defines digital asset management as a collective term applied to the process of storing, cataloguing, searching and delivering computer files (or digital assets). Digital asset management systems, in accordance with damglossary.org (n.d.), centralize assets and establish a systematic approach to ingesting assets so they can be located more easily and used appropriately.
- The Digital Asset Management brochure by Capgemini (2014) provides an impression that digital asset management is all about optimizing and improving physical asset performance by utilizing the historical and operational data that is being produced by these assets.
- Diamond (2012, page 11) highlights that digital asset management, or DAM, describes policies, practices and software an organization uses to manage its digital assets. This definition is the closest one to the asset management definition in ISO 55000 (2014, p.14).

In accordance with Diamond (2014, p.23), the primary components of digital asset management software are:

- Database
- Permission engine that determines who can connect to the system and what users can do once connected to the system;
- Metadata that are values generated by the operating system and include file creation and modification dates and information about the file format, size and location;
- Search Engine that allows searching for files in the DAM;
- Processing Engine that allows processing and modification of the files in the system.

Diamond (2014) highlights that the following steps will be needed, to introduce a DAM:

- Determine the scope of the DAM, define organizational needs and expectations, identify the initiative owner, technical experts, DAM software manager, technical representative and archivist, key department representatives and users;
- Draft an implementation and deployment plan that considers development, testing and launching, promotion of the system and training, and competence that is needed to support the DAM during operation;
- Evaluate the need for integration with other systems of the organization;
- Define and honor policies.

The steps above show some alignment with the requirements of ISO 55001, such as the context of the organization, leadership and policy, planning, support and operation. However, Diamond (2014) does not provide a defined system or a framework for implementation and management of a DAM, but instead compiles general recommendations into a book.

The general result of the DAM landscape analysis provides an impression that the industry is more concerned with software solutions for managing content and digital assets, rather than applying an asset management approach, by integrating digital asset management into a “big picture” of the organizational asset management practices. Of course, a well-functioning software solution for managing digital assets will provide value and significantly contribute to the organizational goals. However, one may observe a potentially big gap in the way how the industry approaches digital asset management in comparison to physical asset management practices. Industry needs to understand differences between managing assets and asset management

Managing Assets	Asset Management
<p>Employees are focused on:</p> <ul style="list-style-type: none"> - Asset data, location and condition assessment - Current KPIs - Department budget 	<p>Employees are focused on:</p> <ul style="list-style-type: none"> - Information supported decisions (strategic context and related to customer needs) - Strategies to select and exploit assets over their lifecycles to support business aims - Collaboration across departments to optimize resources allocated and activities
<p>Stakeholders are focused on:</p> <ul style="list-style-type: none"> - Costs - Current performance - Response to failures / maintaining function 	<p>Stakeholders are focused on:</p> <ul style="list-style-type: none"> - Triple bottom line and value - Clarity of purpose of the organization - Focus on impact of activities on organization's objectives
<p>Top management is focused on:</p> <ul style="list-style-type: none"> - Short term gain / loss - Departmental / individual performance - Savings, especially OPEX 	<p>Top management is focused on:</p> <ul style="list-style-type: none"> - Long term value for the organization - Developing competence and capability across workforce - Business risks understood and mitigated
<p>Suppliers are focused on:</p> <ul style="list-style-type: none"> - Short term contracts and performance - Service level agreements are focused on contract specifications 	<p>Suppliers are focused on:</p> <ul style="list-style-type: none"> - Long term contracts and/or partnering relationships in support of client value and objectives - Understanding client strategy and needs in 5-10 years

Table 4 Differences between managing assets and asset management (ISO, 2017, p. 4)

3.7 Benefits of a management system for digital assets

In general, digital asset management should be covered by the top-level policy, system and practices for the whole organization. Digital assets are essential part of any product developing company and may constitute a portfolio with thousands of terabytes of data. Therefore, it might be necessary to create a separate policy for managing digital assets that is aligned with the top-level asset management policy.

From the perspective of a product developing company, digital assets, that constitute product design, specifications and performance details, are needed in every step of organization's activity:

- New product development: documentation with design and operational parameters, and processes for manufacturing the existing products are often being used as a basis for new product development;
- Sales process: clients want to see information that provides design, interface, performance and operability details of the equipment that is being sold. These details are being captured in 3D models, design documentation and operational manuals.
- Equipment manufacturing and delivery phases: detailed design information and specifications, processes for manufacturing, testing and deploying the products are needed to ensure the necessary quality and reliability of the equipment
- Field support: organizations support their clients for troubleshooting and repairing the equipment after it has been they have been delivered and commissioned. Service personnel will need to have access to all engineering and operational related documentation and drawings for this purpose.

Without being able to create, store, localize at any moment and utilize digital assets, organizations will significantly struggle to deliver their products and services in accordance with client expectations. The digital asset management system will enable organizations to have access and control their product-related documentation, drawings, models and data at any moment. The system will duplicate and back-up the digital assets, so the assets do not get lost or corrupt due to unforeseen issues such as IT system hardware or software failures. The system will ensure that the digital assets are secured from cyber-attacks, stealth by internal and external parties and any other IT safety-relevant threads.

In addition, a system for managing digital assets ensures that digital assets management processes are integrated to and aligned with all other critical organizational processes, for example, related to quality, supply chain, EHS, manufacturing, etc.

4 Approach for Analyzing Digital Asset Management Practices

The analysis of the digital assets management system is based on an interview process with elements of an audit process. This approach was chosen due to the following recommendation in ISO 55002 (2014, p.5):

- An initial review of the organization's current processes against the requirements of ISO 55001 will determine the areas that need to be developed to support the functioning of a compliant asset management system.

The interview process was conducted with 3 managers that were responsible for the digital asset management in OFE BHGE. The interview process was conducted in 3 sessions. Interviews were conducted through skype, since interviewees were in different countries. All interviews were conducted in English. For the sake of the effective interview process, all interviews were audio recorded. It allowed the author of this thesis to be fully engaged in the discussion, eliminate concerns with regards to note taking on paper and have possibility for thorough review of the input after interview. Interviewees were informed about the recording and it was agreed that their personality would not be revealed. All interviewees agreed on the recording.

Each of the 24 clauses in ISO 55001 (2014) were converted into specific questions that would help to evaluate organization's digital asset management practices against the requirements of ISO 55001. In total 46 questions, reflecting the requirements of clauses in ISO 55000 (2014), were addressed to auditees. The list of the questions can be found in Appendix A.

To evaluate the results of the interview, a compliance rating process was utilized. The rating process that was developed by Gulliksen (2017, p.47) and reflects the IAM's Asset Management Maturity Scale, using slightly different criteria and numeration (IAM, 2016).

The rating scale is based on a 1-4 scoring system with the following criteria:

4 - The organization presents asset management practices that can be regarded as compliant with the respective clause of ISO 55001 (2014).

3 - The organization presents good asset management practices, however there are minor elements missing to be regarded as compliant with the respective clause of ISO 55001 (2014).

2 - The organization presents weak asset management practices, presenting severe or several shortcomings compared to the respective clause of ISO 55001 (2014).

1 - The organization presents asset management practices that are of zero compliance with the respective clause of ISO 55001 (2014).

Based on the answers that were provided during the interview, each clause received a compliance rating. The rating of each clause provided an average compliance rating for each chapter. The rounding of the average requirement rating is based on the following intervals, where X represents the average rating of a given requirement prior to rounding:

($X = 4$ gives a rounded score of 4)

($3 \leq X < 4$ gives a rounded score of 3)

($2 \leq X < 3$ gives a rounded score of 2)

($1 \leq X < 2$ gives a rounded score of 1)

The final ratings were used to create a radar chart that visualizes the interview and analysis results.

Whole process is being presented in two steps:

1. A radar chart that shows the overall rating.
2. Discussion of the analysis in a form of text.

The radar chart is being presented first, in Chapter 5, since it provides a good summary of the interview and analysis.

5 Analysis and Results

The results presented in Chapter 5 are based on the responses from the interviewees, three managers of the team that was responsible for the digital assets management at that point of time, provided during the interview sessions.

The radar on Figure 12 and scorecard on Table 5 provide an overview of the interview sessions

Chapter 5.1 to 5.7 provide the detailed results of the interview sessions.

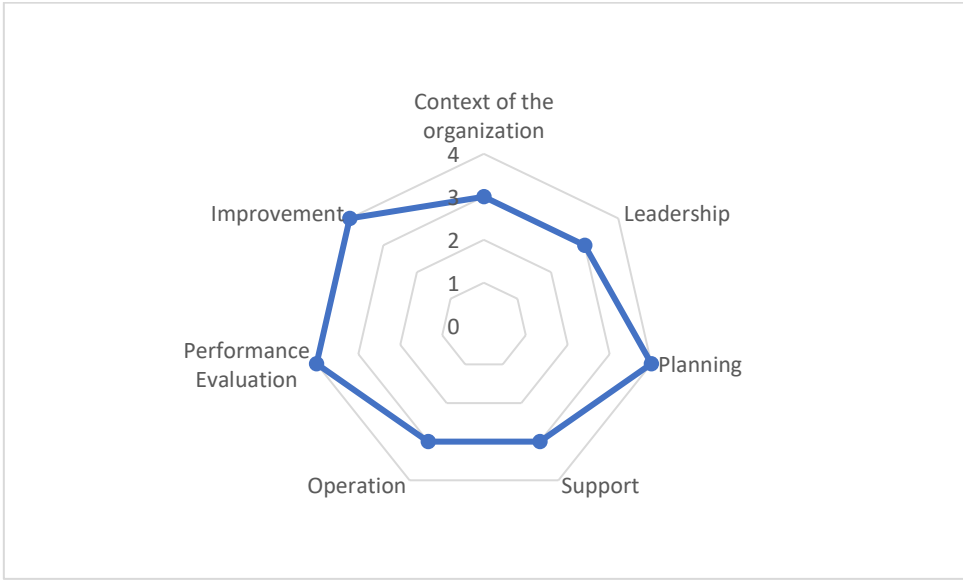


Figure 12 Radar Chart, digital asset management practice in OFE BHGE

	Context of The Organization	Leadership	Planning	Support	Operation	Performance Evaluation	Improvement
Clause 1	4	3	4	4	4	4	4
Clause 2	4	3	4	3	3	4	4
Clause 3	4	4		3	4	4	4
Clause 4	3			4			
Clause 5				4			
Clause 6				4			
Avg.Score	3,75	3,33	4	3,67	3,67	4	4
Rounded Score	3	3	4	3	3	4	4

Table 5 Scorecard, digital asset management practice in OFE BHGE

By studying the radar on Figure 12 and scorecard in Table 5 it becomes evident that there exist several minor performance gaps. The organization shows good asset management practices. The areas related to Context of the Organization, Leadership, Support and Operation receive an average score below 4 due to showing some minor weaknesses in asset management practices compared to the respective clause of ISO 55001 (2014). Chapter 5.8 is discussing the areas where compliance with ISO 55001 (2014) is rated below 4.

5.1 Context of the Organization

Understanding the Organization and its Context

Interviewees were able to provide a good description of the organization that owns and is responsible for managing the digital assets. During interview it was obvious that the context of the organization that manages digital assets is well understood and objectives of it are streamlined with overall company objectives. Context of the Organization document (Appendix B) was shown as an evidence. Document consist of following chapters:

- BHGE Purpose;
- BHGE Brand Promise;
- BHGE Cultural Pillars;
- BHGE Core Behaviors;
- Do the right thing, always;
- BHGE Quality Policy;
- Structure of BHGE;
- BHGE Interested Parties, Internal and External Issues;
- Annex that lists all interested parties, and their needs and expectations.

Goals and objectives of the organization are derived from top-level documents that set business plans and requirements. These documents reflect the requirements from business sponsors and sets the functional, technological and performance expectations to the engineering organization with respect to digital engineering and digital asset management. Requirements are being updated yearly, based on the needs of the stakeholders and other external and internal factors. Further, goals and objectives of the organization are being converted to specific performance expectations towards each employee of the organization.

This approach ensures that each employee is familiar with top level objectives and contributes to achievement of these objectives

Although it is not called a SAMP, organization has a documented and structured method that converts organizational objectives into specific plans for managing digital assets. The role of the system and tools that manage digital assets are derived from those plans.

Interviewees had a good understanding of both internal and external factors that can affect the performance of the digital assets and the system that manages it. Following internal factors were mentioned:

- Availability and integrity of the IT tools and systems;
- Competence of the personnel that is involved in creation of the digital assets;
- Quality processes;
- Organizational goals.

Following external factors were mentioned:

- Trends in the market;
- Trends in digital technology;
- External IT security was mentioned;
- Government regulations.

It was confirmed that both internal and external factors are being considered for managing the digital assets.

With regards to “Understanding the Organization and its Context”, organization presents good asset management practices, that can be regarded as compliant with respective clause in ISO 55000 (2014), and therefore received a rating of 4.

Understanding the Needs and Expectations of Stakeholders

An insightful discussion took place between interviewer and interviewees. Following stakeholders were mentioned by the interviewees:

- Clients;
- Shareholders;
- Company management;
- Users of the system and tools that manage digital assets;
- Manufacturing team;

- Purchasing and sales teams;
- Digital team that is responsible for tools and processes around digital assets;
- Users of the equipment.

Organization has a good understanding of:

- Stakeholders, and their effect on the digital assets and the management system;
- Effect of the digital assets and the management system on the stakeholders.

Expectations and requirements of all stakeholders are gathered in “Context of the Organization” document (Appendix B). Organization has methods for measuring stakeholder satisfaction. Customer satisfaction process (Appendix C), that monitors customers’ perceptions of the degree to which BHGE fulfills their needs and expectations, was given as an example.

Stakeholders are involved in decision making processes with regards to the digital assets management. For example:

- Expectations of the clients, shareholders company managements, functions such as purchasing, manufacturing team, etc., are being reflected in the yearly strategy, goals and subjective documents. In the end of the year performance of each employee and sub-organization, with regards to accomplishment of goals, is being analyzed and evaluated. The results of the performance evaluation are being reported to the top management;
- Numerous surveys gather opinions and inputs of the personnel that uses the system and tools for managing digital assets;
- Top management of the company makes decision with regards to the budget for all projects that improve performance of the digital asset management system. All input from users of the system and tools is being used for improvements.

With regards to “Understanding the Needs and Expectations of Stakeholders”, organization presents good asset management practices, that can be regarded as compliant with respective clause in ISO 55000 (2014), and therefore received a rating of 4.

Determining the scope of the asset management system

Interviewees were able to provide an insightful input with regards to the scope of the asset management system and following was discussed:

- Interfaces with other organizations and the management systems in the company and third parties;
- Responsibilities.

Connections between the scope of the digital assets management system and overall objectives of the organization were shown. A technical and functional specification document describing the scope of the asset management system was created as a part of the asset management system introduction work. Requirements of the other functions in the organization are already reflected in the setup of the tools that manage digital assets.

With regards to “Determining the scope of the asset management system”, organization presents good asset management practices, that can be regarded as compliant with respective clause in ISO 55000 (2014), and therefore received a rating of 4.

Asset management system

It is obvious that organization has a well-functioning digital asset management system that has been active through many years and have been continuously improved. Organization has all necessary processes and a whole group of vendors and employees that are supporting the operation of the digital asset management system. Asset management system is integrated into all other management systems of the organization, such as quality, purchasing, manufacturing, etc.

ISO 55002 (2014, p.6) highlights that an appropriate starting point for introducing an asset management system is the establishment of an asset management policy, which often helps to provide focus for the organization and to identify its intentions. The function of the asset management policy is being compensated by the specification document for the asset management system and the organizational goals and objectives.

As it has been mentioned above in “Understanding the Organization and its Context”, although it is not called a SAMP, organization has a documented and structured method that converts organizational objectives into specific plans for managing digital assets that and is in accordance with practices that are described in ISO 55000 (2014). Asset management system is aligned with these plans.

With regards to “Asset management system”, organization presents good asset management practices. Organization receives a rating of 3, since an asset management policy does not exist, but it is contained in other high level organizational policies or documents. The lack of

asset management policy in the organization can introduce ambiguity when it comes to the scope and boundaries of the asset management system.

5.2 Leadership

Leadership and commitment

Commitment to manage digital assets is on multiple levels of the organization. It is being promoted to all levels of the organization in a form of:

- Integrity policies that highlight importance of the intellectual property to competitive advantage of the company;
- Various internal courses and seminars that discuss the digital asset management related issues;
- Promoting and ensuring the integration of the digital asset management system with the other systems of the organization;
- Internal mass communication through emails and intranet where specific digital asset management related issues are being taken up.

There is a specific organization² in the company that have ownership when it comes to digital asset management.

As it has been mentioned under “Understanding the needs and expectation of stakeholders” and “Determining the scope of the asset management system”, interfaces between digital asset management system and other interested organizations in the company are established and functioning. Management sets yearly goals and objectives to ensure that the digital asset management system is in constant improvement and aligned with organization’s goals and strategy. There is a commitment in the organization when it comes to digital assets management.

With regards to “Leadership and commitment”, organization presents good asset management practices. Organization receives a rating of 3, since an asset management policy does not exist but is contained in other high level organizational policies or documents. ISO 55001 (2014,

² The organization that has been interviewed

p.2) requires that top management shall demonstrate leadership and commitment with respect to the asset management system by ensuring that the asset management policy is established.

Policy

Organization does not have a specific digital asset management policy. Moreover, an overarching asset management policy for the whole company could not be presented during the interview and therefore deemed to be non-existent. However, ISO 55002 (2014, p.7) mentions that it is not necessary for the policy to be captured in a discrete document; it can be contained in other high level organizational policies or documents and if this can be demonstrated, a separate asset management policy document may not be required.

Interviewees were able to tell about context of the organization and intentions of the asset management system and provide references to several documents, such as, design and functional specification for asset management system, documents from quality management system and organizational goals and objectives for 2018, that may contain the essence of a policy.

With regards to “Policy”, organization presents good asset management practices.

Organization receives a rating of 3, due to the fact that an asset management policy does not exist, but is contained in other high level organizational policies or documents. The lack of asset management policy in the organization can introduce ambiguity when it comes to the scope and boundaries of the asset management system.

Organizational roles, responsibilities and authorities

During interview it was noted that organization that manages digital assets was going through changes where its’ management and operational model would be updated and improved; the roles, responsibilities and authorities were not completely settled down and job descriptions were being re-defined. There was a clear timeline with deadlines to complete the process. Company’s change and risk management processes were being utilized for ensuring smooth transition

Organization has a big focus on monitoring the performance of the IT tools that support digital asset management. At the time of the interview there were only few KPIs to monitor and report performance of the system. However, as the part of the organizational change, there was an ongoing work for introducing new KPIs.

The need for the new organization and KPIs were introduced due to organizations good continuous improvement practices. Considering that all these actions are being done in a controlled and systematic manner, it is assumed that the organization will function even better when the change process is completed. Therefore, with regards to “Organizational roles, responsibilities and authorities”, organization presents good asset management practices, that can be regarded as compliant with respective clause in ISO 55000 (2014), and therefore received a rating of 4.

5.3 Planning

Actions to address risks and opportunities for the asset management system

There is a monthly risk review cycle with management where general and specific change related risk and opportunities are being reviewed and discussed. Organization has a general risk assessment and management processes (Appendix D), in addition to project risk management procedures. These are being used when planned changes to the digital assets management being introduced. Risk review and evaluation activities consider impact of the risks on the planned activities, stakeholders and so on.

With regards to “Actions to address risks and opportunities for the asset management system”, organization presents good asset management practices, that can be regarded as compliant with respective clause in ISO 55000 (2014), and therefore received a rating of 4

Asset management objectives and planning to achieve them

Interviewees were able to provide insightful information with regards to the objective of the digital assets management system. There is a technical specifications document for the asset management system that was created prior the introduction of the digital asset management system. The document describes objectives of the system, as well as boundaries, interfaces with the other systems of the organization, etc. Management of the company set yearly goals and objectives to the team that manages digital assets. These goal and objectives reflect organizations strategy, situation in the market, digital technology related issues and all the lessons that were learned during operation of the digital assets management system.

Organization has a documented and structured method that converts organizational objectives into specific plans for managing digital assets. Each planned digital asset and digital asset

management system related activities are well defined in the organizational planning tools with clear timeline and resource allocation. Activities are being planned thoroughly since the downtime of the digital asset management system has significant impact on the business.

With regards to “Asset management objectives and planning to achieve them”, organization presents good asset management practices, that can be regarded as compliant with respective clause in ISO 55000 (2014), and therefore received a rating of 4

5.4 Support

Resources

As it was mentioned in chapter 5.2 Leadership, at the time of the interview, organization was in the process of changing its’ management and operational model which would lead to improvements. System goes through numerous planned maintenance activities and resources for these activities are being assigned in advance. When it comes to the continual improvement, at the time of the interview, organization was mainly dependent on the input and suggestions from the users and the stakeholders of the system. If the need for improvement was very urgent, then the activity and the resources needed for the project would be planned in an ad-hoc manner.

During interview it was noted that a dedicated team, that would specifically be responsible for continual improvement and enhancement of the system that manages the digital assets, was going to be introduced to the organization. Previously these responsibilities were shared between the engineering organization and the quality department that was dealing with continual improvement plans. Introduction of the new continual improvement team that will specifically work with digital assets management will eliminate the organizational bottlenecks.

With regards to “Resources”, organization presents good asset management practices, that can be regarded as compliant with respective clause in ISO 55000 (2014), and therefore received a rating of 4

Competence

When it comes to the competence of the personnel that create and use the digital assets, there is a well-defined competence requirement in the system. Each role has a defined list of education, competency requirements and technical qualifications. This assures that the technical quality of the digital assets is always in accordance with expected functional specification of the client. Right access to right people is crucial for the quality of the digital assets.

Existing personnel that is involved in the maintenance and operations of the digital asset management system and IT technology is qualified and well experienced. However, during interview it was admitted that, methods and processes for reviewing and evaluating for planning future training needs could be improved.

With regards to “Competence”, organization presents good asset management practices. However, due to weakness in the practice of planning future training, organization receives a rating of 3

Awareness

Personnel of the company, both users and those that are responsible for operation of the system, are aware of the way their work and performance affect the digital assets management system, and its’ goals and objectives. Employees of the organization receive digital assets related information from the leadership on a regular basis. There is numerous amount of formal trainings available in the training system of the organization. Organization has a specific portal for digital asset management system (Appendix E), where users and other internal interested parties can get information and attend online courses. Awareness sessions that cover specific topics that may affect performance of the digital assets and its’ system are being organized evenly. The team responsible for the operation of the asset management system organizes regular “questions and answers” sessions.

With regards to “Awareness”, organization presents good asset management practices. However, due to lack of Asset management policy, organization receives a rating of 3. In accordance with ISO 55001 (2014, p.6), persons doing work under the organization’s control, who can have an impact on the achievement of the asset management objectives, shall be aware of the asset management policy. Lack of a centralized asset management policy

document may introduce ambiguity when it comes to the scope and boundaries of the asset management system.

Communication

Information, such as changes, KPIs, matrixes, safety related issues and so on, is being communicated to the internal stakeholders through email, presentations, internal newsletters and other means of communication, by responsible personnel and the management team.

Quality, safety and performance related information is being communicated to the external stakeholders through legal, commercial and other formal communication channels.

In general, organization's top-level processes, that provide guidelines (to whom, when, what and how) with regards to internal and external communication, are being utilized.

With regards to "Communication", organization presents good asset management practices, that can be regarded as compliant with respective clause in ISO 55000 (2014), and therefore received a rating of 4.

Information requirements

Digital assets produce numerous amount of metadata, such as create, review and release dates, names of revising personnel and so on. This metadata is constantly used to improve the release cycles and quality of the digital asset creation and management processes. In addition, there is a constant monitoring of the health data for IT systems. Some of the performance data that is being generated by system will be linked towards specific KPIs for continuous improvement purposes. In general, interviewees admitted that, from operational point of view, there is a room from improvement when it comes to utilization of the data that is being generated by digital assets management system. Need for a fully automated system that would monitor IT systems health data was mentioned as one of the potential improvement areas. It was mentioned that organization had an ongoing project for closing this gap.

With regards to "Information requirements", organization presents good asset management practices. Considering that organization has identified several improvement possibilities for gathering and utilization of the data that is generated by digital asset management system, and working on improvements, organization receives a rating of 4.

Documentation Requirements

The data that specifies the life cycle of the digital asset is being recorded. At any time, it is possible to review all data that is being generated by the digital assets. The requirements for documenting the data, that is being generated by digital assets, are being defined by specific needs of different organizations in the company such as quality, legal, commercial, purchasing, manufacturing, engineering and so on.

However, data that reflects the performance of the digital asset management system is being recorded and documented on limited bases. As it has been mentioned in point above, the process of recording and storing data is automatic only for limited amount data. There is an ongoing work for automating the record of the data in the databases in the organization.

With regards to “Documentation requirements”, organization presents good asset management practices. Considering that the organization has identified several improvement possibilities for documenting the data that is generated by digital asset system and working on improvements, organization receives a rating of 4.

5.5 Operation

Operational planning and control

Organization have planning and control activities in place. Digital asset management related activities are planned with necessary resources and executed and controlled as projects. Team leaders ensure that there are competent human resources who can contribute and deliver expected results of the projects. Program and project managers ensure overall progress of the project and control the timelines, cost, risks, etc. Top managers of the organization receive periodic information with regards to the performance and progress of the projects.

With regards to “Operational planning and control”, organization presents good asset management practices, that can be regarded as compliant with respective clause in ISO 55000 (2014), and therefore received a rating of 4.

Management of change

All risks that can be caused due to changes in the asset management system are being evaluated in advance and in accordance with organization's risk management processes. In addition, before the changes into the system are being deployed, all new functionality is being tested in accordance with procedures. When it comes to risk management of unplanned activities, it will all depend on the criticality of the change and perception of the risk level.

Organization has change a change management process (Appendix F) which are being utilized. However, during interview it was mentioned that the integration process of the digital assets that belong to the recently acquired divisions into the main digital assets management system in BHGE is very slow and can take several years. During these years key engineers, who were responsible for creating those assets, may resign and it can be very challenging for new personnel to understand and make sense of the available design data. At least one example of the similar situation was provided by one of the interviewees. One of the interviewees highlighted that the risks of such actions were evaluated, risks were accepted, and control mechanisms and mitigation actions were implemented. There might have been weak mitigation actions that did not prevent the negative effect, however, the risks were identified in advance.

With regards to "Management of change", organization presents good asset management practices. However, due to some, possibly minor, shortcomings of the Management of Change practices, organization receives a rating of 3. These shortcomings are discussed in chapter 5.8.

Outsourcing

There are several suppliers that provide services to company and involved in the operation of the digital asset management system. Suppliers are working as an integral part of the digital asset management team, however, it was mentioned that a new model for cooperation is being developed. One of the challenges with the outsourcing is that organization does not have a defined services agreement, for example for the software solutions, that are part of the digital asset management system. But this issue will be corrected as a part of the new cooperation model that was being developed at the time of the interview.

All suppliers that are involved in the digital asset management and the system for it are obliged to follow organization's processes and procedures. All suppliers are going to an

extensive qualification process. Suppliers have access to digital assets, however, there is a non-disclosure agreement.

Organization utilizes Purchasing Process (Appendix G) and Supplier Quality Management (Appendix H) process for ensuring that outsourced digital asset management processes are being executed without compromising the integrity of digital asset management system in BHGE.

With regards to “Outsourcing”, organization presents good asset management practices, that can be regarded as compliant with respective clause in ISO 55000 (2014), and therefore received a rating of 4.

5.6 Performance Evaluation

Monitoring, measurement, analysis and evaluation

From the perspective of the company, performance of the digital asset is directly linked to the quality and reliability of the data that is in the asset. For example, a drawing or procedure that can cause any production or operational failures is not a reliable digital asset. However, in most of the cases, failures linked to the quality of the information in the assets will be corrected as soon as this failure is identified. When an asset is being revised due to failures that have been identified during production or operation, a specific “reason for revision” coding will be used in the system. This coding will reflect the reasons for revision, such as failure on the drawing, procedure and so on. Periodically this data is being retrieved from the system and studied by quality department, and top reasons for critical failures are being studied as a part of the continuous improvement process.

The digital assets can be monitored with regards to create, review and release history. During creation, review and release process, engineering quality assurance procedures are used to ensure that the quality and reliability of the content is in order. Once assets are created and uploaded to the digital asset management system, they will be accessible at any time.

Performance of the digital asset management system is being measured by surveys and gathering user and stakeholder feedbacks. Set of KPIs measure the performance of the asset management system. The system is being evaluated with regards to the yearly goals and objectives that are being assigned by the top management. Organization continuously

identification of critical factors that need to be measured and working on implementation of new KPIs.

With regards to “Monitoring, measurement, analysis and evaluation”, organization presents good asset management practices, that can be regarded as compliant with respective clause in ISO 55000 (2014), and therefore received a rating of 4.

Internal audit

Organization goes through yearly audits that are being conducted by external parties. Audits are being conducted against requirements of ISO 9001. In addition, organization has employees that are certified auditors that perform internal audits on smaller scale, against specific processes. All internal and external audit results are being logged in the quality management system. Audit findings that require corrections are being logged in the continuous improvement system and specific action plans are being generated for correcting the finding and closing the identified gaps.

With regards to “Internal audit”, organization presents good asset management practices, that can be regarded as compliant with respective clause in ISO 55000 (2014), and therefore received a rating of 4.

Management review

Performance of the digital assets and digital asset management system is being periodically reviewed by the management. Management studies the KPI trends, most critical non-conformances that could lead to downtimes of the system, internal and external audit results and so on. The management review sessions result in the list of the specific actions that are aimed towards improvements of the performance.

With regards to “Management review”, organization presents good asset management practices, that can be regarded as compliant with respective clause in ISO 55000 (2014), and therefore received a rating of 4.

5.7 Improvement

Nonconformity and corrective action

Organization has systems and processes for managing non-conformances (Appendix I). From the perspective of the organization, a nonconforming digital asset is the one that has wrong data or input that leads to mistakes in purchasing, manufacturing or operating the equipment. There are several channels for communicating the nonconformances, and all stakeholders, such as vendors, engineers, workshop personnel and clients can raise nonconformance concerns. When non-conformant digital assets are identified, a request for investigating the non-conformance, and identifying the immediate corrective actions will be created. Engineering department will review the nonconformity, provide guidance for corrective actions, necessary tests, and initiate a change in the digital asset so similar type of nonconformances can be avoided. Depending on the complexity and impact of the nonconformance, a root cause analysis might be initiated.

The same approach will be taken if a nonconformance has been identified in the asset management system. Asset management system related nonconformances are mainly linked to the functionality of the applications and performance of the IT systems. Therefore, dispositions and corrective actions with regards to the asset management system are performed by IT personnel.

All nonconformities are being logged in the system for future trending and identification of continuous improvement activities.

The trends of the all nonconformances are being studied by quality department periodically and the results are being reviewed with the management of the company. The review process identifies top nonconformance causes and initiates specific actions and plans for improvement.

With regards to “Nonconformity and corrective action”, organization presents good asset management practices, that can be regarded as compliant with respective clause in ISO 55000 (2014), and therefore received a rating of 4.

Preventive action

Organization has several measures for identification of the potential failures in advance. When digital assets are being identified, a review process involving at least 3 competent employees is being initiated. Depending on the complexity of the modification, there will be detailed design reviews of the digital assets. These design reviews may require execution of risk assessment processes such as design FMECA and HAZID.

All changes that are being identified and will be implemented in the digital asset management system are going through thorough change and risk review processes. Before the changes are implemented in the system, they are going through several test regimes to ensure that deployment of the changes will be smooth.

With regards to “Preventive action”, organization presents good asset management practices, that can be regarded as compliant with respective clause in ISO 55000 (2014), and therefore received a rating of 4.

Continual improvement

Organization has a dedicated continual improvement system with procedures where nonconformances, client complaints, results of the internal and external audits, etc. are being logged. A dedicated person with necessary competence for driving the specific nonconformance will be assigned as an Action Owner in the system. Each action a clear execution plan and completion deadline, depending on the complexity.

Organization provides all necessary resources to ensure that there are trained root cause analyzers and auditors. This helps organization to ensure continuous improvement of their digital assets, digital asset management system and supporting processes. Organization has a RCA board that meet on a regular basis and review ongoing nonconformances and the failure trends.

With regards to “Continual Improvement”, organization presents good asset management practices, that can be regarded as compliant with respective clause in ISO 55000 (2014), and therefore received a rating of 4.

5.8 Performance Gaps and Improvement Areas

Context of the organization and Leadership

The system that is used for managing digital assets in OFE BHGE has deep roots, has been operated and continuously improved through several decades. It is a well-functioning system that provides a competitive advantage to the organization. However, it lacks an asset management policy document. On the one hand, ISO 55002 (2014, p.4) states that an appropriate starting point for introducing and operating an asset management system is the establishment of an asset management policy, which often helps to provide focus for the organization and to identify its intentions. On the other hand, ISO 55002 (2014, p.7) mentions that it is not necessary for the policy to be captured in a discrete document; it can be contained in other high-level organizational policies or documents, and if this can be demonstrated, a separate asset management policy document may not be required. In a competent and confident manner, interviewees were able to tell about context of the organization and intentions of the asset management system and provide references to several documents that could contain the essence of a policy, such as:

- Design and functional specification for asset management system;
- Documents from quality management system;
- Organizational goals and objectives for 2018.

While it is the duty of the managers to be aware of these kinds of documents, it is important that organizational context and intentions with regards to the asset management are clear at every level³. Lack of asset management policy can damage the culture of asset management in the company. Management needs to influence the organization positively. ISO 55001 (2014, p.2) highlights that one of the ways for the top management to demonstrate leadership and commitment with respect to the asset management system is to ensure that the asset management policy is established and is compatible with the organizational objectives.

Creation of a separate asset management policy document is a definitive area for improvement.

³ This is also reflected in a clause 7.3 Awareness in ISO 55001 (2014)

Support

The organization should recognize that there is interdependency between its asset management competencies, its organizational design and business processes (ISO 55002, p.14). During the interview it was mentioned that methods and processes for reviewing, evaluating and planning future training for the team that is involved with the maintenance and operations of the digital asset management system could be improved. This issue was not presented to be as a very critical one and any specific details supporting this input were not given. No matter what, this input is in contradiction with ISO 55001 (2014, p.5) which clearly states that organization shall review current and future competency needs and requirements. One of the most important elements of the digital asset management system is the IT technologies, which tend to be developing and improving so quickly that most of the industry is not able to follow this up. Personnel that is involved with the maintenance and operation of the digital asset management system have a direct impact on the availability of the digital assets. Hence it is essential to ensure that OFE BHGE improves methods and processes for reviewing and evaluating the competence, as well as planning future training for this team.

Operation

As it has been mentioned in chapter 5.5, the organization has all the necessary change management processes that are supposed to be utilized. However, during the interview it was brought to attention that it can take a very long time before digital assets of the recently acquired divisions are implemented into BHGE's central digital asset management system and tools. ISO 55001(2014, p.8) has 3 "shall" requirements concerning Management of Change:

First - Risks associated with any planned change, permanent or temporary that can have an impact on achieving the asset management objectives, shall be assessed before the change is implemented.

Second - The organization shall ensure that such risks are managed in accordance with Chapter 6.1 and 6.2.2 in ISO 55001 (2014)

Third - The organization shall control planned changes and review the unintended consequences of changes, taking action to mitigate any adverse effects, as necessary.

Observing the discussion around Management of Change topic, the author of this thesis made the following conclusions:

- There might be several reasons, such as cost saving, low or zero demand for the products in the market, etc., for the organization not integrating the digital assets of the recently acquired divisions into the central digital asset management system and tools immediately. The impression is that the decision was thought through, risks were assessed, and mitigation actions were implemented. Therefore, organization was compliant with the first “shall” requirement relevant to Management of Change;
- The second “shall” requirement defines that risks shall be managed in accordance with Chapter 6.1 in ISO 55001, which refers to chapter 4.2 Understanding the need and expectations of stakeholders. Chapter 4.2 requires that the organization shall determine the requirements and expectations of these stakeholders with respect to asset management. One of the most important stakeholders of OFE BHGE is the client, who requires the support services for the products that were delivered previously. How can an organization provide product support to clients, when the quality of the digital assets that include technical data about the product might be compromised? In this specific case, the organization is not compliant with the second “shall” requirements relevant to Management of Change;
- The requirements of the third “shall” statement did not seem to be compromised, since the organization controlled the changes, reviewed the unintended consequences of the delayed integration process and improvement actions were implemented in the system.

6 Discussions, Observations and Suggestions for Further Studies

6.1 Scope of Work and Objectives

The primary objective of this thesis was to evaluate the application of ISO 55000 suite (2014) for managing digital assets. This was done by assessing and mapping the digital asset management practices in OFE BHGE against recommendations and requirements of the ISO 55000 suite (2014). The idea was simple:

- Conduct an interview with questions that would reflect the requirements and recommendations of ISO 55001 (2014);
- Observe if any requirements of ISO 55001 (2014) could not be utilized for digital asset management;
- Discuss the idea of applying ISO 55001 (2014) for managing digital assets.

As an outcome of the evaluation process, the application of ISO 55000 (2014) suite for managing digital assets is being discussed under chapter 6.2.

As a secondary aim, the results of the evaluation were supposed to provide an overview of the gaps and improvement areas with regards to the digital asset management practices in OFE BHGE. An interview with 3 managers who were responsible for the digital asset management in OFE BHGE was conducted. Each of the 24 clauses in ISO 55001 (2014) were converted into specific questions. These questions would help to evaluate organization's digital asset management practices against the requirements of the ISO 55001. In total 46 questions, reflecting the requirements of clauses in ISO 55000 (2014), were addressed to interviewees. Gaps and improvement areas were identified during the interview process in OFE BHGE and discussed in chapter 5 as an outcome of the evaluation process.

Familiarization with the terminology of asset and asset management was a first necessary step for evaluation and mapping the digital asset management practices in OFE BHGE, against recommendations and requirements of the ISO 55000 suite (2014). In addition, basic familiarization with the concepts of digital asset and digital asset management was required. Detailed study of ISO 55000 suite (2014), extensive review of asset management related academic and industrial literature, and online sources helped the author of this thesis to:

- Elaborate subjects of assets in general, physical and digital assets, and digital intellectual property assets;
- Explain the idea of asset management by covering areas of definition, history, fundamentals, conceptual models and benefits of asset management;
- Provide basic insights into subject of digital asset management.

The second step for gaining necessary knowledge for evaluation of the digital asset management practices in OFE BHGE, against recommendations and requirements of the ISO 55000 suite (2014), was familiarization with the subject of asset management system, and ISO 55000 suite (2014). A significant amount of time was used for familiarization with ISO 55001 (2014). This resulted in a chapter 3.5 that discusses the subject of the asset management system and provides a detailed review of all 7 areas and 24 clauses of ISO 55001 (2014). In addition, for preparing a better ground for the evaluation of the digital asset management practices in OFE BHE, chapters 3.6 and 3.7, that are discussing the digital asset management systems and benefits of digital asset management system, were created.

Based on the above, it can be concluded that the defined scope of work and objectives of the thesis were met.

6.2 Observations and Findings

Application of ISO 55000 suite for managing digital assets

As it has been mentioned through the whole document, the main goal of this thesis is to evaluate the application of ISO 55000 suite (2014) for managing digital assets. The outcome of the interview process in BHGE provides a definitive conclusion:

- Yes, ISO 55001 (2014) can be used for managing digital assets, trade secrets in particular. Moreover, ISO 55000 suite should be utilized actively for this purpose.

There are several factors that contribute to this conclusion. First of all, the whole idea of the interview by utilizing the framework of ISO 55001 was accepted positively by the interviewees. The interview was a good way for managers to step aside and evaluate the practices of digital asset management in a new and unbiased way. Each of the 46 questions, that were based on 24 clauses of ISO 55001 (2014), were understood by interviewees and were deemed to be relevant. This could be observed because:

- The lively discussions that took place during the interview were not about the relevancy of the questions. Discussions were between the interviewees who were addressing the questions and providing the answers.
- Interviewees were able to provide answers to all questions.

Observations above confirmed the requirements of the ISO 55001 (2014), which were covered by the interview questions, to be relevant to the digital asset management practices.

Second, the general opinion of the interviewees was that ISO 55001 (2014) could be used for managing digital assets. Considering that interviewees are working with digital assets management daily, this is a significant feedback that supports the idea of utilizing the ISO 55000 suite for managing digital assets.

Third, as it has been mentioned in chapter 3, the fundamentals of asset management consist of Value, Alignment, Leadership and Assurance. Digital assets are created and maintained for bringing value to the organizations, by aligning with organizational objectives and plans. Organizations need to assure that digital assets fulfil their purpose and effectively contribute to the value creation. The role of the management and leadership in these tasks are undeniable. ISO 55000 suite translates all 4 fundamentals of the asset management into a framework that provides guidance and sets requirements to a system that manages assets. To claim that the ISO 55000 suite is not suitable for managing digital assets, or possibly any other type of assets than physical assets, is to ignore the value that can be brought by ISO 55000 suite to an organization. One must remember that, for the time being ISO 55000 suite is the only international standard for asset management.

It also needs to be highlighted that, digital assets management should not be looked upon as a separate discipline in an organization. It is important that digital asset management is covered by the overall asset management policy and practices of the organizations. However, based on the size of the digital asset portfolio in the organizations, it might be necessary to create a separate policy for digital asset management. Separate policy for the digital asset management shall be fully aligned with the organization's asset management policy.

Digital Assets Management Practices in Oilfield Equipment division of Baker Hughes, GE Company.

Even though OFE BHGE does not have any commitment to be compliant with ISO 55001 at the time being and none of the interviewees had any initial knowledge of ISO 55000 suite, the interview and evaluation process has shown that OFE BHGE has good practices of digital asset management.

With regards to Planning, Performance Evaluation and Improvement requirements in ISO 55001 (2014), the organization presents asset management practices that can be regarded as compliant.

With regards to Context of the Organization, Leadership, Support and Operation requirements in ISO 55001 (2014), the organization presents good asset management practices, however there are minor elements missing to be regarded as fully compliant.

The results are not surprising. The system that is used for managing digital assets in OFE BHGE has deep roots and has been operated, and continuously improved through several decades. It is a well-functioning system that provides a competitive advantage to the organization. BHGE is very aware of its' own intellectual property rights, and role of the intellectual property and digital assets in the success. It is an ISO 9001 certified company and is well known for its' Lean Six Sigma continuous improvement methods. However, there are some findings that require attention:

- The organization does not have any dedicated asset management policy. ISO 55002 (2014, p.4) states that an appropriate starting point for introducing and operating an asset management system is the establishment of an asset management policy. It is important that organizational context and intentions with regards to the management of assets are clear at every level. Lack of a dedicated asset management policy can have a negative effect on the culture of the asset management in the company. Due to lack of the dedicated asset management policy, the organization was not fully compatible with several clauses (in Context of the Organization, Leadership and Support) that have requirements concerning interfaces with the policy document.
- Methods and processes for reviewing, evaluating and planning future training for the team that is involved with the maintenance, and operations of the digital asset management system and tools could be improved. IT tools are one of the most important elements of digital asset management system in OFE BHGE. IT

technologies develop and improve so quickly that most of the industry is not able to follow this development up. Personnel that is involved with the maintenance and operation of the digital asset management system have a direct impact on the availability and accessibility of the digital assets. It is important to ensure that OFE BHGE improves methods and processes for reviewing and evaluating the competence, as well as planning future training for this team.

- Some weaknesses in the utilization of management of change processes were highlighted during the interview. It can take a very long time before digital assets of the recently acquired divisions are implemented into the BHGE's main digital asset management system and tools. This leads to organization being not compliant with the second "shall" requirements relevant to Management of Change in ISO 55001 (2014).

Digital Asset Management

Definition of digital asset management vary from one source to another. A google search for "Digital Asset Management" or "Management of Digital Assets" brings millions of results. Digital asset management solutions are called DAM by the industry. While in-depth analysis regarding the state of the art of the digital asset management practices was not the goal of this thesis, the general result of the DAM landscape analysis provides an impression that the industry is more concerned with software solutions for managing content and digital assets, rather than applying an asset management approach by integrating digital asset management into a "big picture" of the organizational asset management practices. One can see a possible gap in the way how industry approaches the digital assets management in comparison to physical asset management practices. During a LinkedIn chat session with Mark Davey, who is Editorial Board Member of "Journal of Digital Media Management" and former president of "DAM Foundation" that existed in 2012-2016, confirmed that the DAM industry does not have any standards.

It is necessary to highlight that the author of this thesis tried to get in touch and arrange an interview with Institute of Asset Management on the topic of Digital Asset Management. Unfortunately, it was not possible to establish a contact with the responsible people in IAM.

6.3 Areas for Further Study

The thesis concludes that application of the ISO 55000 suite for digital asset management is feasible and recommended. In this thesis, the evaluation of digital asset management practices is limited to digital assets, such as trade secrets, that were created by engineering organization in OFE BHGE. It could be very interesting to utilize similar approach for evaluating digital asset management practices in the public health services sector which has enormous amount of data, such as patient records, research results, etc. It might be interesting to evaluate how the public health sector treats patients, most important stakeholders, with respect to patient data, which is a digital asset for the hospitals. Does the public health sector treat patient data as digital asset at all?

As it has been highlighted in chapter 1.5 Limitations, the scope of this thesis is to extract the essence and main points of the all 72 “shall” statements of ISO 55001 (2014), rather than reflect each of the requirements in a specific question. A more detailed study of the digital asset management practices against requirements of all 72 “shall” statements in ISO 55001, will provide a better understanding with regards to the applicability of this standard for digital asset management. An alternative can be to evaluate the application of the conceptual model that was created by IAM (2015), together with all 39 Asset Management subjects, for managing digital assets.

Finally, it could be very interesting to conduct an in-depth research of the state of art when it comes to digital asset management. Are there any standards or digital asset management concepts that are utilized by the industry? One of the findings of the thesis is that industry is more concerned with software solutions for managing content, rather than integrating the digital asset management into a “big picture” of the organizational asset management practices.

7 Conclusion

The main aim of this thesis was to assess the application of ISO 55000 suite (2014) for digital asset management. Assessment is done by evaluating and mapping the digital asset management practices in BHGE against requirements of the ISO 55001 (2014). The outcome of the assessment provides a definitive conclusion:

- Yes, ISO 55001 (2014) can be used for managing digital assets, trade secrets in particular. Moreover, ISO 55000 suite should be utilized actively for this purpose.

Considering that OFE BHGE, for the time being, does not have any commitment to be compliant with ISO 55001 and none of the interviewees had any initial knowledge of ISO 55000 suite, the interview and evaluation process shows that OFE BHGE has good practices of digital asset management.

Digital assets management should not be looked upon as a separate discipline in an organization. It is important that digital asset management is covered by the overall asset management policy and practices of the organizations. However, based on the size of the digital asset portfolio in the organizations, it might be necessary to create a separate policy for digital asset management. Separate policy for the digital asset management shall be fully aligned with the organization's asset management policy.

Digital asset management solutions are called DAM by the industry. The general result of the DAM landscape analysis provides an impression that:

- The DAM industry does not have any standard
- The DAM industry is more concerned with software solutions for managing content and digital assets, rather than applying an asset management approach to integrate the digital asset management into a "big picture" of the organizational asset management practices.

One can see a possible gap in the way how industry approaches the digital assets management in comparison to physical asset management practices.

8 Bibliography

Amadi-Echendu, J.E., 2010. Behavioural Preferences for Engineering Asset Management. In Amadi-Echendu, J.E., Brown K., Willett R., Mathew J., (eds.), 2010. *Definitions, Concepts and Scope of Engineering Asset Management*, Springer

Amadi-Echendu, J.E., Willett R., Brown K., Hope T., Lee J., Mathew J., Nalinaksh V., Yang B., 2010. What is Engineering Asset Management. In Amadi-Echendu, J.E., Brown K., Willett R., Mathew J., (eds.), 2010. *Definitions, Concepts and Scope of Engineering Asset Management*, Springer

Amcouncil.com.au, 2017. *Asset Management Concept Model*. [Online] Available at: <http://www.amcouncil.com.au/download.aspx?DocId=2266> [Accessed 30 October 2018]

Bhge.com, 2018. *Baker Hughes, a GE company Announces Third Quarter 2018 Results*. [Online] Available at: <https://www.bhge.com/news/baker-hughes-ge-company-announces-third-quarter-2018-results> [Accessed 09 December 2018]

Bhge.com, n.d.. *About our company*. [Online] Available at: <https://www.bhge.com/our-company> [Accessed 10 November 2018]

Bhge.com, n.d.. *We invent smarter ways to bring energy to the world*. [Online] Available at: <https://www.bhge.com/sites/default/files/2017-07/BHGE101-Infographic.pdf> [Accessed 09 December 2018]

Bouchoux D.E., 2006. *Protecting Your Company's Intellectual Property: A Practical Guide to Trademarks, Copyrights, Patents and Trade Secrets*. Amacom.

Business-benefits.org, n.d.. *University Health System generates cost savings from ISO 55001*. [Online] Available at: <http://business-benefits.org/case-study/university-health-system-became-the-worlds-first-accredited-hospital-to-be-certified-to-the-iso-55001-standards/> [Accessed 25 November 2018]

Cambridge Dictionary, n.d. *Asset*. [Online] Available at: <https://dictionary.cambridge.org/dictionary/english/asset> [Accessed 31 August 2018].

Codifiedconsultant.com, n.d.. *Six Steps to Digital Asset Management Success*. [Online] Available at: <https://codifiedconsultant.com/collections/free-dam-materials/products/six-steps-to-digital-asset-management-success> [Accessed 30 October 2018]

Corporatefinanceinstitute.com, n.d.. *Types of Assets*. [Online] Available at: <https://corporatefinanceinstitute.com/resources/knowledge/accounting/types-of-assets/> [Accessed 02 September 2018].

Damglossary.org, n.d.. *Dam Glossary*. [Online] Available at: <https://damglossary.org/> [Accessed 30 October 2018]

Diamond D., 2012. *DAM Survival Guide: Digital Asset Management Initiative Planning*. [Kindle version] Amazon. [Accessed 20 October 2018].

Digitalassetmanagement.com, 2015. *Understanding the Digital Asset Lifecycle: Defining and Connection the Four Stages*. [Online] Available at: <https://www.slideshare.net/widen/understanding-digital-asset-lifecycle-white-paper> [Accessed 08 December 2018]

Edwards, R., 2010. *Asset management in the rail and utilities sector*. In: Lloyd, C., (ed.), 2010. *Asset management: Whole-life management of physical assets*, ICE Publishing.

Efinancemanagement.com, n.d.. *Meaning and Different Types of Assets*. [Online] Available at: <https://efinancemanagement.com/financial-accounting/meaning-and-different-types-of-assets> [Accessed 02 September 2018].

Frolov, V., Ma L., Sun Y., Bandara W., 2010. Identifying Core Functions of Asset Management. In Amadi-Echendu, J.E., Brown K., Willett R., Mathew J., (eds.), 2010. *Definitions, Concepts and Scope of Engineering Asset Management*, Springer

GFMAM, n.d. *GFMAM Presentation*. [Online] Available at: http://www.gfmam.org/files/20100513_GFMAM_Final.pdf [Accessed 30 October 2018]

Gulliksen, M. T., 2017. *Asset Management Practices in Norwegian Industrial Sectors*. [Online] Available at: <https://brage.bibsys.no/xmlui/handle/11250/2460098> [Accessed 09 October 2018].

Halligan R.M. and Weyand R.F., 2018. *Trade secret asset management 2018*. [Kindle version] Weyand Associates, Inc. [Accessed 09 October 2018].

- Hastings, N.A.J., 2010. *Physical Asset Management*. Springer
- IAM, 2015. *Asset management – an anatomy (version 3)*. [Online] Available at: <http://theiam.org/knowledge/Knowledge-Base/the-anatomy> [Accessed 29 October 2018]
- IAM, 2016. *Asset Management Maturity Scale and Guidance (Version 1.1)*, Institute of Asset Management.
- ISO 55000, 2014. *Asset management – Overview, principles and terminology*. International Organization for Standardization.
- ISO 55001, 2014. *Asset management – Management systems – Requirements*. International Organization for Standardization.
- ISO 55002, 2014. *Asset management – Management systems – Guidelines for the application of ISO 55001*. International Organization for Standardization.
- ISO, 2017. *Managing Assets in the context of Asset Management*. [Online] Available at: <https://committee.iso.org/files/live/sites/tc251/files/stories/ISO%20TC251%20WG4%20MACAM%20May%202017%20EN.pdf> [Accessed 04 December 2018]
- ISOfocus, 2017. *Our flightpath to the future*. [Online] Available at: [https://www.iso.org/files/live/sites/isoorg/files/news/magazine/ISOfocus%20\(2013-NOW\)/en/2017/ISOfocus_120/ISOfocus_120.pdf](https://www.iso.org/files/live/sites/isoorg/files/news/magazine/ISOfocus%20(2013-NOW)/en/2017/ISOfocus_120/ISOfocus_120.pdf) [Accessed 25 November 2018]
- Liyanage, J.P., 2012. Smart Engineering Assets Through Strategic Integration: Seeing Beyond the Convention. In Van der Lei, T., Herder P., Wijnia, Y., (eds), 2012. *Asset Management : The State of the Art in Europe from a Life Cycle Perspective*, Springer
- Lloyd C., 2010. Introduction. In: Lloyd, C., (ed.), 2010. *Asset Management: Whole-life management of physical assets*, ICE Publishing
- Medium.com, n.d.. *The difference between cryptocurrency and digital assets, and why should holders care?* [Online] Available at: <https://medium.com/@xaurumofficial/the-difference-between-cryptocurrency-and-digital-assets-and-why-should-holders-care-33e00c62a3b9> [Accessed 10 November 2018]
- Mentzas, G., Apostolou D., Abecker A. and Young R., 2003. *Knowledge Asset Management. Beyond the Process-centered and Product-centered Approaches*. Springer.

Nastasić, D.L., Koronios, A., Haider, A., 2010. Integration Through Standards – An Overview of Internal Information Standards for Engineering Asset. In Amadi-Echendu, J.E., Brown K., Willett R., Mathew J., (eds.), 2010. *Definitions, Concepts and Scope of Engineering Asset Management*, Springer

Nvfnorden.org, 2016. *UIS Railway Application Guide – Practical Implementation of Asset Management Through ISO 55001*. [Online] Available at: http://www.nvfnorden.org/library/Files/Utskott-och-tema/Drift-och-underhall/M%C3%B8ter-og-protokoller/UIC%20ISO%2055000%20Guidelines_final.pdf [Accessed 25 November 2018]

Oxford Dictionary, n.d. *Asset*. [Online] Available at: <https://en.oxforddictionaries.com/definition/asset> [Accessed 31 August 2018].

Oxford Dictionary, n.d.. *Asset management*. [Online] Available at: https://en.oxforddictionaries.com/definition/asset_management [Accessed 01 September 2018].

PAS 55-1, 2008, *Asset Management – Part 1: Specification for the optimized management of physical assets*. British Standards Institution

PAS 55-2, 2008, *Asset Management – Part 2: Guidelines for the application of PAS 55-1*. British Standards Institution

Pilling, M., 2010. Beyond BSI PAS 55 compliance. In: Lloyd, C., (ed.), 2010. *Asset Management: Whole-life management of physical assets*, ICE Publishing

Press, G., 2015. *A Very Short History of Digitization*. [Online] Available at: <https://www.forbes.com/sites/gilpress/2015/12/27/a-very-short-history-of-digitization/#1f1d154549ac> [Accessed 10 November 2018]

Raschke R.L. and Mann A., 2017. *Enterprise Content Risk Management: A Conceptual Framework for Digital Asset Risk Management*. *Journal of Emerging Technologies in Accounting*, Vol 14, No 1. Available through: University of Stavanger Library Website https://bibsyst-almaprmo.hosted.exlibrisgroup.com/primo-explore/fulldisplay?docid=TN_crossref10.2308%2Fjeta-51735&context=PC&vid=UBIS&lang=no_NO&search_scope=default_scope&adaptor=primo_central_multiple_fe&tab=default_tab&query=any,contains,Enterprise%20Content%20Risk

[%20Management:%20A%20Conceptual%20Framework%20for%20Digital%20Asset%20Risk%20Management&sortby=rank&offset=0](#) [Accessed 09 October 2018].

Teece, D. J., 2000. *Managing intellectual capital*. Oxford University Press.

The Institute of Asset Management, 2015. *Asset Management – an anatomy*. [Online] Available at: <http://www.nvfnorden.org/library/Files/Utskott-och-tema/Drift-och-underhall/M%C3%B8ter-og-protokoller/An%20anatomy%20v3.pdf> [Accessed 30 October 2018]

Theiam.org, n.d. *About us*. [Online] Available at: <https://theiam.org/about-us/> [Accessed 11 December 2018]

Too, E.G., 2010. A Framework for Strategic Infrastructure Asset Management. In Amadi-Echendu, J.E., Brown K., Willett R., Mathew J., (eds.), 2010. *Definitions, Concepts and Scope of Engineering Asset Management*, Springer

Woodhouse, J., 2013. *Setting a good standard in asset management* [Online] Available at: <http://www.twpl.com/wp-content/uploads/Setting-a-good-standard-for-asset-management-Times-20131.pdf> [Accessed 25 November 2018]

Woodhouse, J., 2014. *Briefing: Standards in asset management: PAS 55 to ISO 55000*. In: Kumar, A., (ed.), 2014. *Infrastructure Asset Management*.

Worldcryptoindex.com, n.d.. *Differences Between Digital Assets, Tokens and Coins*. [Online] Available at: <https://www.worldcryptoindex.com/differences-between-digital-assets-tokens-coins/> [Accessed 10 November 2018]

www.amcouncil.com.au, n.d. *About the Asset Management Council*. [Online] Available at: <https://www.amcouncil.com.au/about-us/what-is-the-asset-management-council.html> [Accessed 11 December 2018]

Appendix A – Interview Questions

Questions	Notes
Chapter 4 - Context of the organization	
Chapter 4.1 - Understanding the organization and its context	
1. Tell me about the organization (and its structure) that manages the digital assets that has been created by engineering?	Definition of organization – ref to 3.1.13 in ISO 55000
2. What are the objectives of this organization and how these objectives are being aligned with overall company objectives? How is it ensured that objectives are aligned with overall company objectives?	Definition of objective – ref to 3.1.12 in ISO 55000
3. Where can employees of the organization find the objectives of this organization?	
4. What are the external and internal factors that can affect the performance of the assets?	
Chapter 4.2 - Understanding the needs and expectations of stakeholders	
5. Who are the stakeholders of the organization? How each group of the stakeholders affect the organization?	Definition of stakeholder – ref to 3.1.22 in ISO 55000
6. What are the requirements of the stakeholders when it comes to the performance and integrity of the assets? Are these requirements documented and communicated to the organization?	Definition of requirement – ref to 3.1.20 in ISO 55000 Definition of performance – ref to 3.1.17 in ISO 55000
7. How do you measure satisfaction of the stakeholders?	
8. How are stakeholders involved in the decisions making processes related to the asset management?	
Chapter 4.3 - Determining the scope of the asset management system	
9. What is the scope of the asset management system and where it is documented?	
10. How is asset management system integrated with the processes of other organizations in the company such as quality, legal, engineering and so on?	
Chapter 4.4 - Asset management system	
11. Is there a strategic asset management plan for managing digital assets?	Definition of strategic asset management plan – ref to 3.3.2 in ISO 55000
12. Is digital asset management system aligned with strategic asset management plan and asset management policy?	
Chapter 5 - Leadership	
Chapter 5.1 - Leadership and commitment	

13. How is top management and leadership of the organization committed to management of the digital assets?	Definition of top management – ref to 3.1.23
14. How are these commitments communicated to the organization?	
15. How do top management and leadership create and support the culture for the digital asset management?	
Chapter 5.2 – Policy	
16. Please show me the digital asset management policy	Definition of asset management policy – ref to 3.1.18
Chapter 5.3 - Organizational roles, responsibilities and authorities	
17. Are there clear organizational roles and responsibilities for managing digital assets?	
18. How does information related to performance of the digital asset management system being reported to the top management?	
Chapter 6 - Planning	
Chapter 6.1 - Actions to address risks and opportunities for the asset management system	
19. How does organization address the risks and opportunities related to digital assets / intellectual assets?	Definition of risk – ref to 3.1.21 in ISO 55000
20. Does risks and opportunities evaluation method consider how risks and opportunities affect organizational goals, plans and stakeholders' expectations?	
Chapter 6.2 - Asset management objectives and planning to achieve them	
21. What are the objectives of the digital assets / intellectual property management system? Where can these objectives be found? How often these objectives are being updated / reviewed?	
22. Is there a plan that supports the achievement of the digital assets / intellectual property objectives? Ref above. Does this plan specify activities and resources that will be required so objectives can be met?	Definition of asset management plan – ref to 3.3.3 in ISO 55000
Chapter 7 - Support	
Chapter 7.1 - Resources	
23. How does the organization determine and provide resources needed for the maintenance and continual improvement of the asset management system for the digital assets?	Definition of continual improvement – ref to 3.1.5 in ISO 55000
Chapter 7.2 - Competence	
24. How does organization assure that it has necessary competence for a functional asset management system?	Definition of competence – ref. to 3.1.3 in ISO 55000
25. How is this competence being evaluated and updated?	
Chapter 7.3 - Awareness	

26. Are personnel in the company aware how their work affects achievement of asset management objectives and asset performance? How is this awareness being raised?	
Chapter 7.4 – Communication	
27. How is asset relevant information being communicated to or exchanged with internal and external stakeholders?	
Chapter 7.5 – Information requirements	
28. What kind of data do assets produce? To improve asset performance and contribute towards achievement of the organization objectives, how is this data being used?	
Chapter 7.6 – Documented information	
29. How does asset relevant data is being documented and what kind of requirements are applicable?	
Chapter 8 - Operation	
Chapter 8.1 - Operational planning and control	
30. Does your organization have operational planning and control processes to support the effective delivery of the activities contained within the asset management plans?	
Chapter 8.2 - Management of change	
31. How does organization assess the outcomes of the planned or unplanned changes that may affect the operability and integrity of the digital assets?	
32. Are there change management processes?	
Chapter 8.3 - Outsourcing	
33. Are there any digital asset management related activities that are being outsourced to external parties?	
34. How does organization ensure that outsourced asset management activities are delivered in a way that the outcome does not compromise the operability and integrity of the digital asset and their management system?	
35. How does organization ensure digital data that is being passed to external parties for manufacturing purposes are legally safe from the organizations perspective? How does ensured that the intellectual assets / property will not be leaked or stolen by the external parties?	
Chapter 9 - Performance evaluation	
Chapter 9.1 - Monitoring, measurement, analysis and evaluation	
36. How does organization measure performance of the digital assets and their management system?	
37. Does top management review performance of the digital asset management system? If yes, how often and in which format?	

38. Where and how does organization record documented information as evidence of the results of monitoring, measurement, analysis and evaluation.	
39. Do parameters that are being measured and monitored reflect the expectations of the stakeholders?	
Chapter 9.2 - Internal audit	
40. Does organization conduct audits for evaluating the digital asset management system?	
41. Which requirements are being used as a basis for the audit?	
42. To ensure its continuing suitability, adequacy and effectiveness, how often is asset management system being reviewed by management? In which format? Where can one find the report / summary?	
Chapter 10 - Improvement	
Chapter 10.1 - Nonconformity and corrective action	
43. How does organization deal with non-conformances?	
44. Are all non-conformances being logged in the system? Is it possible to trace them?	
Chapter 10.2 - Preventive action	
45. Does organization have processes that proactively identify potential failures in asset performance and evaluate the need for preventive action?	
Chapter 10.3 – Continual improvement	
46. What kind of continual improvement activities does organization have?	

Appendix B – Context of the Organization



Level: L2 - Procedure Tier: GLB - Global
 Document Type: Procedure
 Sub Element: BHGE
 Doc Number: [REDACTED]
 Rev: 2
 Effective Date: 17 Sep 2018

Context of the Organization

Purpose

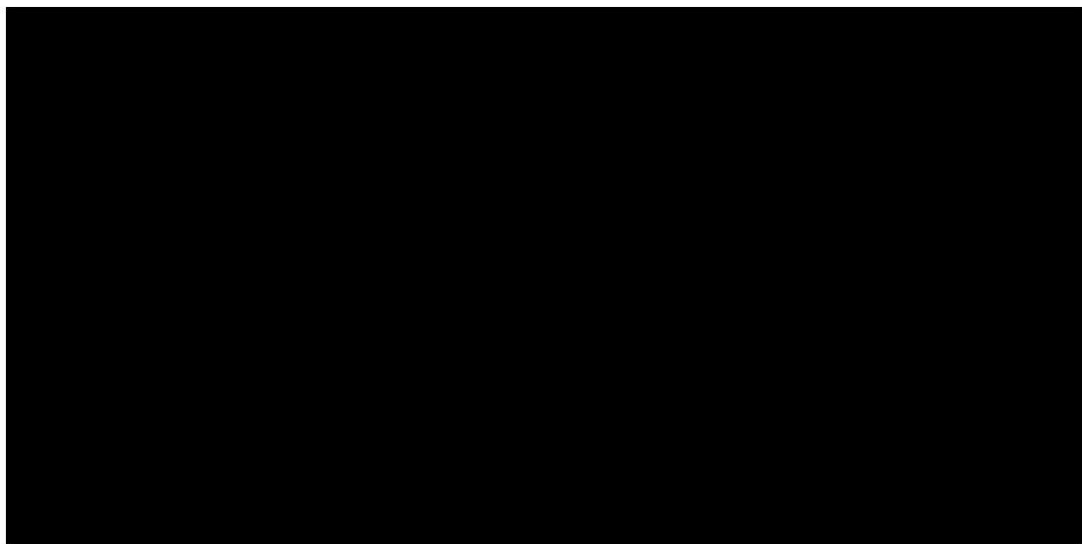
The purpose of this procedure is to describe the context of Baker Hughes, a GE Company, including the identification of Interested Parties and Internal and External Issues.

Scope

This document applies to all Baker Hughes, a GE Company, Product Companies and Functions.

Description of Activity

1. BHGE Purpose



Revision History					
Rev.	RDR	Amendment Detail	Reviewer	Approver	Effective Date
Current Revision					
2	2563/dc	Updated section 7 to reflect change in BHGE structure.	[REDACTED]	[REDACTED]	17 Sep 2018
1	--	Initial Release	[REDACTED]	[REDACTED]	28 May 2018

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Appendix C – Customer Satisfaction



Level: L2 - Procedure Tier: GLB - Global
 Document Type: Procedure
 Sub Element: BHGE
 Doc Number: [REDACTED]
 Rev: 1
 Effective Date: 9 Apr 2018

Customer Satisfaction

Purpose

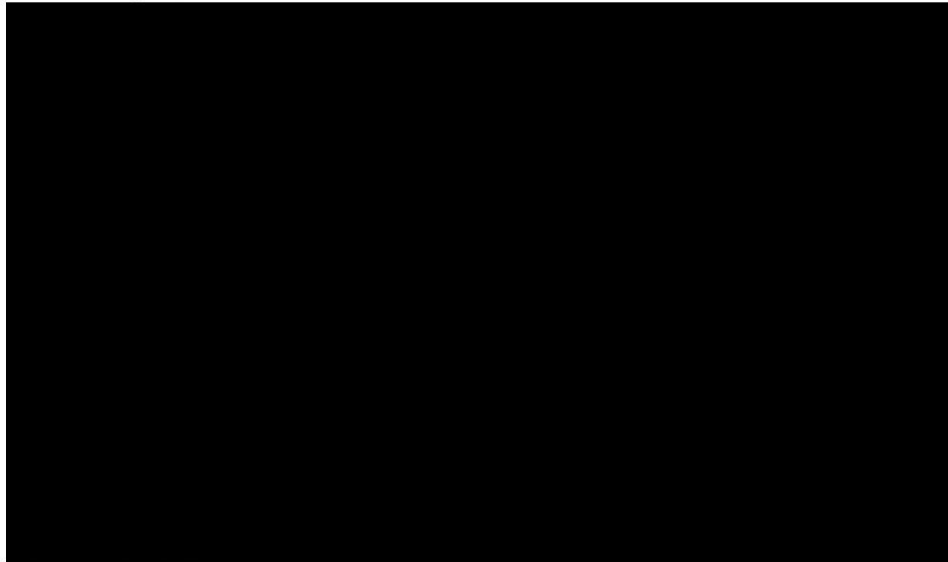
The purpose of this document is to establish the process to monitor customers' perceptions of the degree to which BHGE have fulfilled their needs and expectations.

Scope / Application

This document applies to all Baker Hughes, a GE Company, Product Companies and Functions.

Description of Activity

1. General Requirements



2. Customer Complaints



Revision History					
Rev.	RDR	Amendment Detail	Reviewer	Approver	Effective Date
Current Revision					
1	--	Initial Release	[REDACTED]	[REDACTED]	9 Apr 2018
Three Previous Revisions					

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Appendix D – Risk Assessment and Management



Level: L2 - Procedure Tier: GLB - Global
 Document Type: Procedure
 Sub Element: BHGE
 Doc Number: [REDACTED]
 Rev: 2
 Effective Date: 23 Jul 2018

Risk Assessment and Management

Purpose

The purpose of this procedure is to define the process to identify and control risk associated with the execution of service and delivery and quality of product as well as the elements used to address preventive, risk based actions and opportunities.

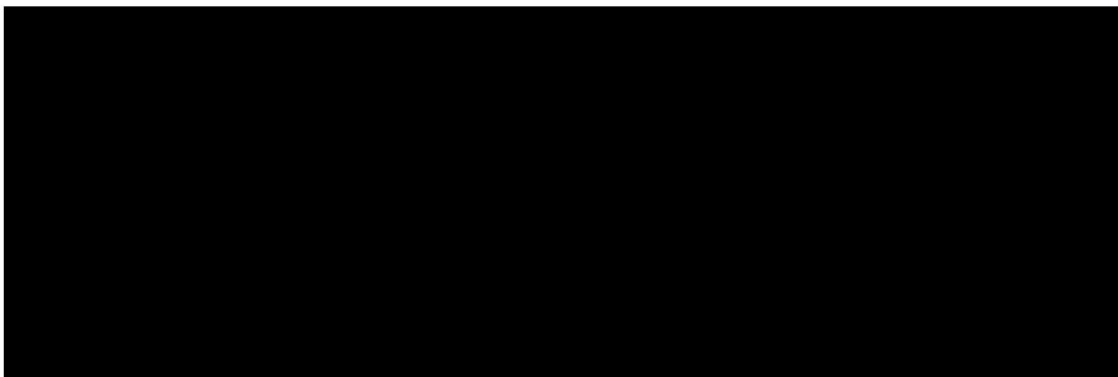
Scope

This document applies to all Baker Hughes, a GE Company, Product Companies and Functions.

The requirements in this procedure identified as [Supplemental API Q1] and/or [Supplemental API Q2] are mandatory for those organizations with active API Monogram Licenses, API Q1 and/or API Q2 Registrations or claiming API Q1 and/or Q2 conformity.

Description of Activity


1. General




Revision History					
Rev.	RDR	Amendment Detail	Reviewer	Approver	Effective Date
Current Revision					
2	2379/dc	Updated the purpose to include preventive actions. Added sections 9.2.2 and 9.2.3. Added the reference of BHGE-QUA-031 to 9.1 and to the Reference section. Added Preventive Actions to the Records section.	[REDACTED]	[REDACTED]	23 Jul 2018
Three Previous Revisions					
1	--	New Release	[REDACTED]	[REDACTED]	25 Apr 2018





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Appendix E – Digital Asset Management System Portal





TRAINING & SUPPORT

Feature Set Podcast

PLM SUPPORT

Express Video Tutorials

We have developed a range of express video tutorials to help answer some of the most common Teamcenter queries.

Use the dropdown below to select a video.

Please Select

PLM Tips

Every week we release a PLM tip to help you discover features and improvements in Teamcenter. Missed one of these weekly tips? Dont worry! We have them all archived here.

Please Select

Hypercare Support

Most issues can be answered by using the materials available on this support site, however our dedicated team of Teamcenter specialists (Hypercare) are available to help you with all of your Teamcenter issues.

Please find details of your nearest HyperCare assistant in the table below:

Location	Name	SSO
Aberdeen	Sujatha Muliyil	502665662
Aberdeen	Murali Natarajan	502730171
India (Offshore Support)	Vignesh Balaji	503003452
Italy	Rajarajan Anbalagan	503003904
Houston	Kanagatunga Gopinath	503018404
Norway	S. Priyadharshini	502329602
Norway	Umaji Pali	502723648
Nalleae/Latvia	Bharath Kumar	502723648
Warsaw	Krzysztof Kolos	212314437
India	Tijo Jose	502690328

Contractor - SC Access

To be able to access all of the materials on this support site, Non-SHGE employees and contractors must complete a workflow.

Select the button below to complete the workflow.

Note: This is not for requesting access to Teamcenter. See the section titled requesting access to Teamcenter.

Request Contractor Access

ONLINE TRAINING MATERIALS

Online User Guides

The new online user guides are developed for all users. These interactive guides are searchable and content is broken down into bitesize chapters.

First time users are encouraged to view the content in order of their appearance, however those requiring a quick refresh may jump from section to section.

Whatever your role, these guides are your starting point.

Please Select

GE Learning Courses

Please use the dropdown to discover the list of eLearning courses available over on GE Learning. Be advised that our PLM curriculum is currently under review and courses are being refreshed to improve learning and user experience.

Please Select

Additional Resources

In addition to the content already provided on this site, we have compiled a list of further training materials that may be useful in expanding your PLM Knowledge.

PLM Quick Guides

- ▶ [Change Management](#)
- ▶ [Documents](#)
- ▶ [Interfacing Systems](#)
- ▶ [Parts & BOMs](#)
- ▶ [SCR](#)

Userguides

- ▶ [Teamcenter Userguides](#)
- ▶ [User Self-Help](#)

Self Led Training

- ▶ [Introduction to Classification.pptx](#)

iPEM Design Instructions

- ▶ [Linking to Design change work instructions](#)

Legacy Training Modules

Please use the new **iPEM online user guide** for all iPEM training. These modules are no longer updated and may provide inaccurate information, these are provided for reference only.

Please Select

CLASSROOM TRAINING

Classroom Training

90% of users do **not** require classroom training for Teamcenter.

If you regularly, more than twice a month, create documents, drawings or approve workflows then you will require an authoring (write access) account for Teamcenter and must complete the classroom training.

For consumer (read only) accounts you can find all relevant training material on this site and can contact the hypercare team with the occasional write request.

Book Training

TRAINING CALENDAR

Location	Topic	Date
Houston	iPEM	December 10-14
Aberdeen	Teamcenter	January 14-16
Montrose	Teamcenter	January 21-25
Nalleae	Teamcenter	January 21-25
Houston	Teamcenter	February 4-8
Vietnam	Teamcenter	February 11-15
Warsaw	Teamcenter	February 11-15
London	Teamcenter	February 16-22
Singapore	Teamcenter	February 16-22
Jandira	Teamcenter	March 4-6
Jandakot	Teamcenter	March 11-15
Aberdeen	Teamcenter	March 16-22

CLASSROOM MATERIALS

Please find the presentations and materials used during the classroom training provided below.

- ▶ [415 PLM Create and Update Project BOMs V...](#)
- ▶ [420 PLM Part Management V1.4.pptx](#)
- ▶ [424 PLM Fundamentals of DPP using Teamce...](#)
- ▶ [427 PLM CAD Integration Management V0.4...](#)
- ▶ [429 PLM Creating MDRs V0.9.pptx](#)
- ▶ [430 PLM Document Management V1.3.pptx](#)
- ▶ [441 PLM Writing Good Requirements V0.3.p...](#)
- ▶ [442 PLM BOM Management V0.4.pptx](#)
- ▶ [443 PLM Managing Special Customer Requir...](#)
- ▶ [Teamcenter Sourcing Training Manual V2.0...](#)

Appendix F – Managing Change in BHGE



Level: L2 - Procedure Tier: GLB - Global
 Document Type: Procedure
 Sub Element: BHGE
 Doc Number: [REDACTED]
 Rev: 1
 Effective Date: 23 Jul 2018

Managing Change at BHGE

Purpose

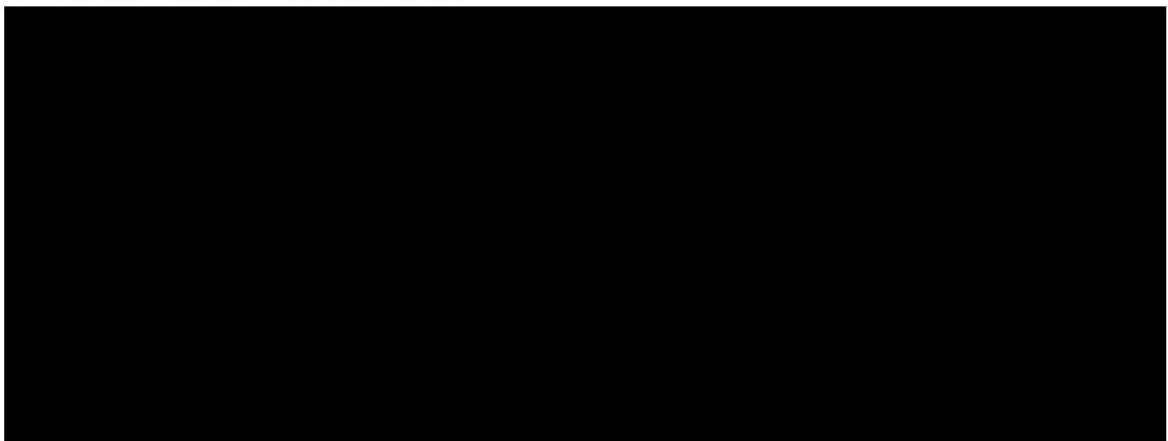
This document defines the methodology and criteria to manage change at BHGE with the end goal to direct employees to the appropriate change process in order to reduce or mitigate risks to personnel, property, plant and equipment, product or service delivery and the environment.

Scope

This document is applicable to all BHGE Product Companies and functions and covers activities resulting from *Planned or Unplanned Changes*.

Description of Activity

1. Managing Change Requirements - General



Revision History					
Rev.	RDR	Amendment Detail	Reviewer	Approver	Effective Date
Current Revision					
1	--	Initial Release	[REDACTED]	[REDACTED]	23 Jul 2018
Three Previous Revisions					

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Appendix G – Purchasing Process



Tier: GLB - Global Document Type: Procedure
 Element / Subelement: BHGE
 Doc Number: [REDACTED]
 Rev: 1
 Effective Date: 6 Sep 2018

Purchasing Process

Purpose

The purpose of this procedure is to define the requirements for the activities related to the procurement of goods, processes or services for Baker Hughes, a GE Company.

Scope

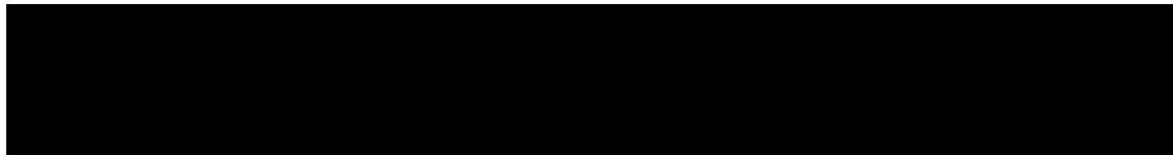
This document applies to all Baker Hughes, a GE Company, Product Companies and Functions when procuring goods, processes and services from entities both inside and outside of BHGE. This document does not cover expediting activities after PO placement.

Purchase transactions in which the supplier is an Affiliate of BHGE or GE will follow the exceptions mentioned in 12.3.

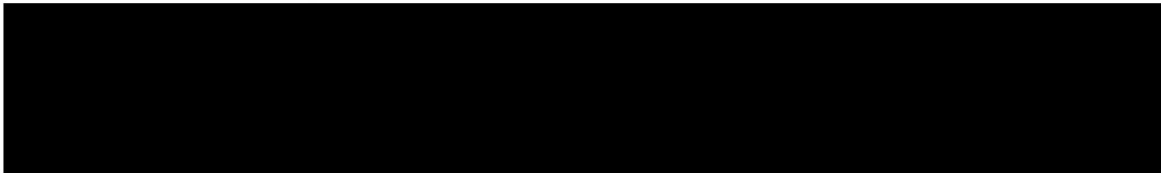
Purchase Orders can be issued only to suppliers onboarded per BHGE-SOU-008 "Supplier on-boarding" and, if required, qualified per BHGE-QUA-014 "Supplier Quality Management" (refer to 6.1).

Description of Activity

1. General



2. Purchase Order Request (POR)



Revision History					
Rev.	RDR	Amendment Detail	Reviewer	Approver	Effective Date
Current Revision					
1	--	Initial Release	[REDACTED]	[REDACTED]	6 Sep 2018
Three Previous Revisions					

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Appendix H – Supplier Quality Management



Level: L2 - Procedure Tier: GLB - Global
 Document Type: Procedure
 Sub Element: BHGE
 Doc Number: [REDACTED]
 Rev: 1
 Effective Date: 23 Jul 2018

Supplier Quality Management

Purpose

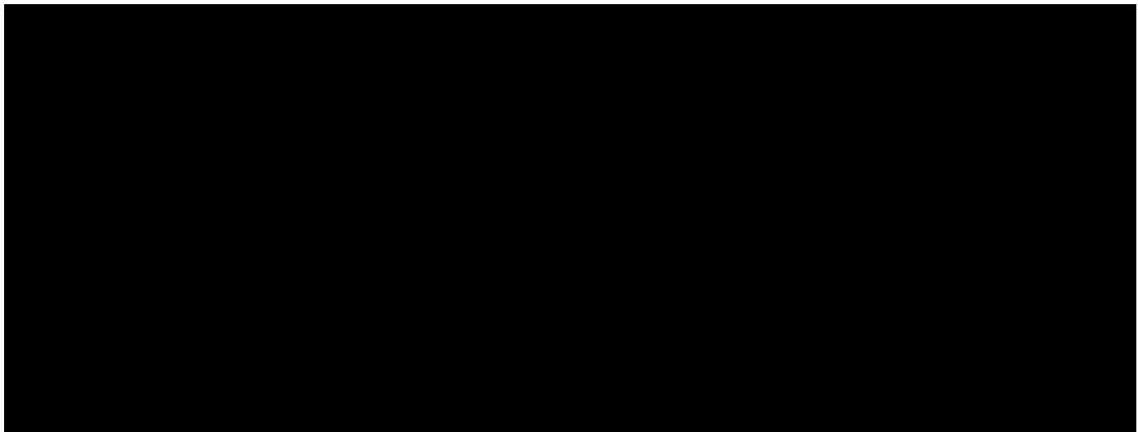
The purpose of this document is to establish the minimum requirements for Supplier Quality Management, including initial evaluation (on-boarding, process assessment and product qualification) and re-evaluation, to ensure that externally provided products, processes and services conform to specified requirements.

Scope

This document applies to all Baker Hughes, a GE Company, Product Companies and Functions and to all direct and indirect suppliers that provide processes, products and services which BHGE transact through the issuance of purchase orders and payments.

Description of Activity

1. General



Revision History					
Rev.	RDR	Amendment Detail	Reviewer	Approver	Effective Date
Current Revision					
1	--	Initial Release	[REDACTED]	[REDACTED]	23 Jul 2018

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Appendix I – Control of Nonconforming Product and Services



Level: L2 - Procedure Tier: GLB - Global
 Document Type: Procedure
 Sub Element: BHGE
 Doc Number: [REDACTED]
 Rev: 1
 Effective Date: 29 May 2018

Control of Nonconforming Product and Services

Purpose

The purpose of this document is to establish the process and the responsibilities for the identification and control of nonconforming products and services that do not conform to specified requirements to prevent the unintended use, delivery or installation.

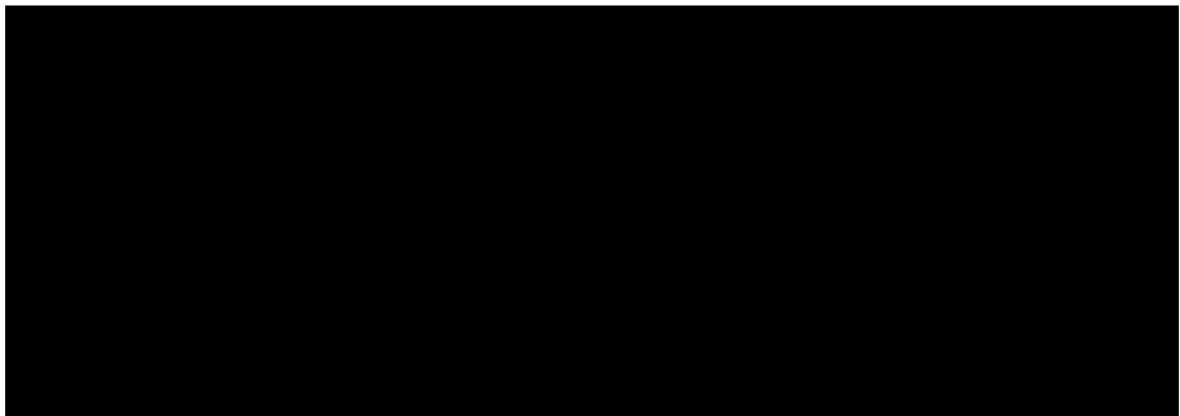
Scope

This document applies to all Baker Hughes, a GE Company, Product Companies and Functions.

The requirements in this procedure identified as [Supplemental API Q1] and/or [Supplemental API Q2] are mandatory for BHGE Organizations with active API Monogram Licenses, API Q1 and/or API Q2 Registrations or claiming API Q1 and/or Q2 conformity.

Description of Activity

1. Identification, Control and Documentation



Revision History					
Rev.	RDR	Amendment Detail	Reviewer	Approver	Effective Date
Current Revision					
1	--	Initial Release	[REDACTED]	[REDACTED]	29 May 2018

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