Development of strategic asset management planning in the petroleum industry

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Abstract

Purpose – Due to the certain risk carried in offshore petroleum installations, the integrity of these installations needs to be maintained at all times. Thus, asset integrity management (AIM) needs to be formulated and monitored to achieve the integrity objective. The purpose of this paper is to study the practices and progression of strategic AIM planning in the petroleum industry.
Design/methodology/approach – The paper is written based on a literature study, observations and data collected from industry practitioners through an online questionnaire and interviews to study the AIM practices in their organization. Validation of the results is performed through respondents' reviews and cross-referencing with existing literature and supplemental data.
Findings – The paper identifies, analyses and validates the work structure in formulating an AIM strategic plan.
Research limitations/implications – Even though the research focuses on the AIM practices of offshore petroleum installations, the result can be implemented in similar fields.
Originality/value – Researchers or practitioners can benefit from the knowledge gained of current practices and the presented work structure in establishing an AIM strategic plan.

Keywords Asset management, Strategy, Petroleum, Strategic planning, Oil and gas, Asset integrity management
Paper type Research paper

Introduction and background

Asset integrity management (AIM) is an adaptation of asset management (AM), especially in the petroleum industry, due to the definite risk it bears that requires integrity to be maintained over the entire life cycle. As part of the management of physical assets, AIM has brought a holistic approach in managing the life cycle of a physical asset (Ritchie, 2011). In this industry, AIM activities have expanded from the pre-operation phase through to the decommissioning phase. In addition, AIM activities, such as maintenance and inspection, have also shifted from playing a tactical role to playing a strategic role (Sollee *et al.*, 1995; Tsang, 1998).

A study by Pinjala *et al.* (2006) found that organizations that competing on quality (i.e. quality-competitors) have better planning process and control systems when compared to others. This means that an organization can be directed toward reaching a certain competitive advantage. The study also found that there is a relationship between business strategy and maintenance strategies, where the maintenance strategy seem to be in line with their business

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and objectives of the company (Pinjala *et al.*, 2006). However, unlike maintenance strategy, AIM strategy covers a larger area across business and technical disciplines in the internal and external organization, which increases its vulnerability (Janele *et al.*, 1998).

Moreover, often AIM strategies fail due to the lack of both integration and unified effort from different groups in the organization (Ciaraldi, 2012; Parida *et al.*, 2015). Thus, different groups in the organization need to be led toward the same goal, and to align different groups the organization needs to develop a strategy and a plan to implement it (Steiner, 1979). For this to happen, there is a need for AIM strategic planning (SP), where AIM activities are directed to achieve the organizational strategy (El-Akruti and Dwight, 2013; Woodhouse, 2003).

The notion of SP has been around since the 1960s and has been discussed, implemented and improved in so many ways (see e.g. Mintzberg, 1994; Killen *et al.*, 2005; Haines, 2000). However, there is a lack of SP models designated for AIM in the petroleum industry and that have received feedback from industry practitioners (see e.g. Al-Turki, 2011; Capon *et al.*, 1987; Grant, 2003). Additionally, there is a limited amount of literature on SP within the petroleum organizations, and most of the analyses were not based upon the notion of SP processes (Grant, 2003).

To fill this gap, this study focuses the practices and progression of AIM SP. The paper will be taking an example from the petroleum industry due to the importance of AIM in this industry, particularly for offshore installations. Data collection will involve a questionnaire, interviews with industry practitioners and supplemental sources provided by respondents to support the interview data. The analysis will be instigated by finding the key variables in the organizations' AIM SP practices and then linking them to the characteristics of the respondents' organizations.

AIM SP in the petroleum industry

The management of asset integrity is gained through integrated access and control over the installation in order to achieve the desired integrity (Bai and Liyanage, 2012; Sulaiman and Husin, 2000). In the petroleum industry, the desired integrity level is the capability of an installation to perform its required function in a prescribed manner.

AIM

AIM is a part of AM. The term "asset" in this study refers to the physical asset, and the term "integrity" takes the meaning of technical integrity. Within the petroleum industry, the technical integrity of an asset is normally associated with the ability of the asset to perform its required function in a safe, effective and efficient manner, particularly with the ability to safely contain or process hydrocarbons and other related substances according to the defined function and stated requirements (Jansen and Firing, 2016). A petroleum asset will degrade, and it can only perform its required function if preserved properly over its life. To be able to sustain the desired integrity level, an organization needs to balance the asset's capabilities against the AIM constraints, safety, risks and the associated budget over its life cycle as illustrated in Figure 1. In Figure 1, the term "capability" of an asset refers to the ability and potential of an asset to achieve its intended functional performance, production performance and availability performance (Ratnayake and Markeset, 2010) in a safe, timely and high-quality manner. The elements related to "risk" in this context cover all the possible consequences (outcomes) of an event, including hazard, threat or opportunity (ISO 55000:2014). The elements related to "resources" are the organization's commitment to spending what is required for the installation's expenditures, including various resources. The elements related to "constraints," however, are parallel to various inherited challenges faced by the offshore installation, such as production challenges, technical challenges, degradation, weather, geographical conditions, etc. (Kusumawardhani and Ratnayake, 2013, Javaherdashti *et al.*, 2013). These main areas must be balanced out optimally and sustainably in order to reach the desired integrity level and maximize return on investment, as shown in Figure 1.

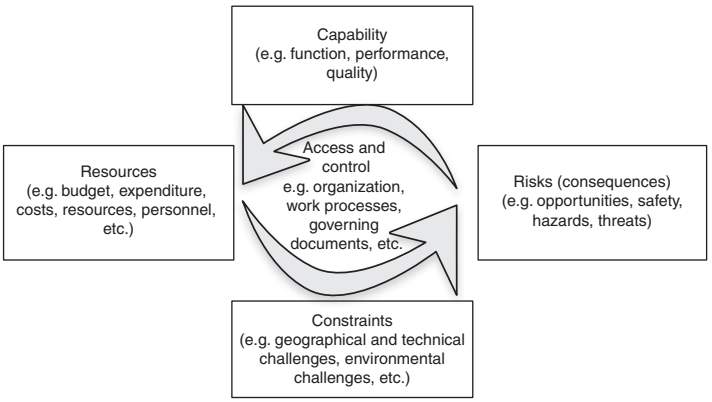


Figure 1.
Balancing the AIM areas of an offshore production installation

Thus, in this study, AIM will be defined as: "the development, execution and evaluation of a coordinated plan together with managerial control and organizational activities, to ensure that the physical asset is carrying out its intended performances in a safe, effective and efficient manner over its entire lifecycle, in order to achieve the organizational objectives" (Kusumawardhani *et al.*, 2017).

SP

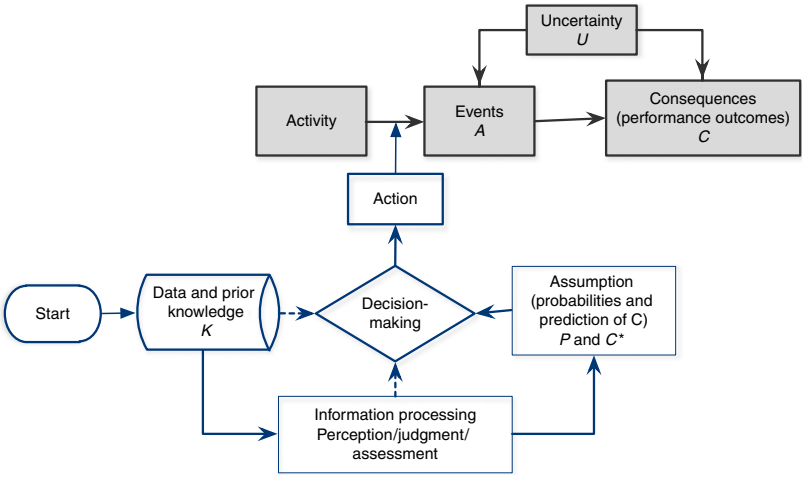
Planning is not new in the petroleum industry, and the term "planning" has a clear and definite meaning as the process or activity of making plans. However, the terms "strategic" and "strategic planning" (SP) seem to be vague and are understood differently by scholars and practitioners (Nag *et al.*, 2007; Carr and Smeltzer, 1997). The term "strategic" is often related to the organizational interest or important matters, which would affect the well-being of the organization, and SP is related to the planning of that important matter (Steiner, 1979).

Different scholars have also suggested that SP is part of the long-term corporate planning, but, regardless of the different views on SP, most of the definitions describe SP as an organizational process that attempts to anticipate future decision-making by forecasting the probability of consequences that arise from current action and knowledge (Capon *et al.*, 1987; Miller and Cardinal, 1994; Al-Turki, 2011). The result is formulated in strategies and planning that will drive and allocate the organization's resources to achieve the organization's objectives.

Another characteristic of SP is that it is a form of a continuous systematic process that begins by defining organizational aims and establishing strategies to achieve them (Steiner, 1979). The process is continuous in order to be able to adapt to the changes in the internal and external environment, especially with the fluctuating fossil fuel price and the rapidly changing technology in the petroleum industry (Kusumawardhani and Markeset, 2015).

From the discussion, it is foreseeable that SP is the way for an organization to deal with uncertainties. Additionally, SP is essentially a process of identifying opportunities and threats that are significant to the organization's objectives. The SP process facilitates organizations to perform decision-making processes to secure their competitive advantage in the future. The act of planning is performed to direct their resources' allocation and anticipate the future situation.

A similar process was defined by Aven (2008) as risk (C, C^*, U, P, K), as shown in Figure 2. According to this definition, risk is the consequences (C) of the activity (including the initiating event A), which is affected by uncertainties (U) that are associated with whether or not A will occur and which values C will take. C^* is the



Source: Aven (2008)

Figure 2.
Decision-making process based on risk description (*C*, *C**, *U*, *P*, *K*) (Aven, 2008)

prediction of *C*, and *P* the probabilities of how likely various events and outcomes are, and they are based on prior knowledge (*K*).

In this definition, risks are both opportunities and threats, including all possible consequences that might arise, which in AIM would include business and technical terms. This definition will delineate the term "risks" throughout this paper. Related to this definition, the SP process is essentially a decision-making process to manage foreseeable risks, and it may be linked to strategic decision-making (Grant, 2003). Additionally, Capon *et al.* (1987) also emphasize the continuous process loop in SP to tackle the volatile business environment. Thus, for the purpose of this paper, SP is defined as "a systematic and continuous process of risks identification that uses probabilities and other knowledge as a basis to forecast consequences to undertake anticipatory decision-making of resources allocations to achieve the organization's objectives" (Steiner, 1979; Capon *et al.*, 1987; Aven, 2008).

Recent development of strategic AIM planning

Since the 1990s, the SP practices in the petroleum industry have changed into a more informal and decentralized process to adapt to the turbulent and unpredictable business environments (Grant, 2003). This creates a semi-structured process, where the bottom-up decentralization allows more freedom for business units to formulate their own strategy, without losing certain control from the organization (Brown and Eisenhardt, 1997). Larger organizations would normally establish a set of performance standards or key performance indicators (KPI) for their offshore units, but nowadays it is a more common practice for divisional business units, such as operation and maintenance, to have more influence on their department's strategy.

The volatile environment also formed a more responsive strategic decision-making, which creates a shorter-term for SP and is more focused on performance management and goals, as well as more into performance management and goal-focused (Grant and Cibin, 1996). This term stretches the definition of SP, which was previously viewed as long-term planning, into a process, which is more adaptive to the strategic decision-making. This change provides a strong background for a petroleum installation's quarterly appraisals and its business units, which are updating their plans yearly.

Mankins and Steele (2006) stressed that the differences between strategic decision-making and SP, and claim that SP is about documenting choices that have already been made rather than about making decisions. This is in accordance with Mintzberg (1994), who distinguished between deliberate strategy and emergent strategy. The first was based on original intention, and the latter consists of the organization's responses to a variety of unanticipated events. The delineation between the two brings forward the continuous improvement characteristic in the SP process, which enables incidental decision-making to be incorporated into the plan. Successful organizations have figured out a way to integrate these two processes, as observed by Brown and Eisenhardt (1997), such that the organization's consideration of the present and future (plans) gives a direction for change.

For AIM of petroleum installations, long-term SP is established at the design phase and reflected in the life cycle plan with a span of around 25-30 years, while the shorter-term SP is normally reflected in five-year and yearly plans and monitored in a timely manner through performance measurement or performance management (Grant and Cibin, 1996; Tsang, 1998; Grant, 2003; Parida and Kumar, 2009). In accordance with bottom-up decentralization, divisional SP is assigned to related business units, for example, to the operations and maintenance department, which drives the development of SP in this area (see e.g. Horner *et al.*, 1997; Tsang, 1998; Murthy *et al.*, 2002; Al-Turki, 2011). From thereon, the SP evolves alongside the progression of operations and maintenance management into AIM (Ratnayake, 2012).

The establishment of AM was buoyed by the publication of PAS 55 in 2004 and the ISO 55000 series in 2014 (Standardization, 2014). AIM has been known in the petroleum industry as an integrated management of the petroleum installation to achieve the desired integrity. Besides method and research developments in AIM (e.g. Baby, 2008; Ratnayake, 2012; Bharadwaj *et al.*, 2012), there have also been developments in software that are promoting "integrated" access to strategic areas of AIM (Quinn *et al.*, 2007; Kusumawardhani and Markeset, 2015). Therefore, since the focus has shifted to AIM, it will be beneficial to study the SP process in this area.

Study method

Research was conducted to study the practices and progression of AIM SP in organizations with petroleum installations. Respondents work in the petroleum industry and were given the same set of questions. The study utilizes a mixed method and consisted of two parts, a semi-structured guided interview and a questionnaire (Brannen, 2005), as illustrated in Figure 3. The semi-structured guided interview was mostly performed face-to-face whenever possible, while, in the second part, respondents were asked to fill in a questionnaire.

The interview method was chosen primarily to observe the phenomenon from the respondent's point of view through a structured approach, while the questionnaire aimed to observe the trends amongst the respondents (Creswell, 2003). To maximize the reliability and validity of measurement and to attain a better understanding of the organization's strategy, all of the respondents held senior management positions. However, views from other non-management employees were also collected whenever possible and taken into consideration to represent both perspectives and triangulation of data. Triangulation of the result is also achieved by cross-reference with the organization's procedures, processes and publicly available resources such as the organization's website.

Both methods were performed with the cooperation of six industry practitioners located in Norway and Houston, Texas, USA. Face-to-face interviews were conducted with the four respondents located in Stavanger and Oslo, Norway, and one respondent in Houston was contacted through e-mails. All of the respondents have 10-33 years of experience in the petroleum industry and all hold managerial positions in installation management and at a corporate level. To diversify the respondents' perspectives of the petroleum industry,

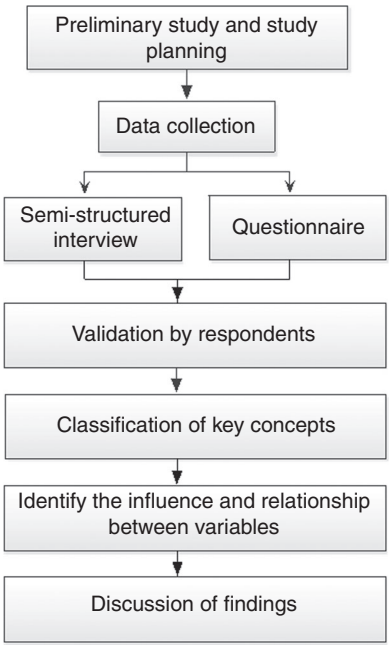


Figure 3.
AIM strategic planning study method

respondents were taken from service users and service providers, with four respondents working for operator companies and the other two, for service companies. All respondents are working in multi-national organizations and their field of responsibilities are all related to AIM, operations and maintenance of petroleum installations. Two of the respondents are working for small- to medium-sized organizations ($\leqslant 250$ employees) and the others are working for a larger organizations (> 250 employees).

Research questions and analysis methods

The questions were developed through the literature study and from observations, as well as with the collaboration of senior researchers. The questionnaire addressed the background information of AIM SP in the organizations, while the interviews aimed to study the practices of AIM and AIM SP related to the petroleum installation, the performance management of the strategy and potential improvements around this area. Preliminary questions addressed the organization's practices in AIM in relation to the petroleum installations and then progressively moved toward the process of developing AIM strategy and how they measure the strategy performance. The respondents were also asked to evaluate a SP process based on Haines (2000) model as shown in Figure 4. This model was chosen because of the general terms it uses and the detailed steps of the process. The figure was also modified to fit into this study topic.

Most of the reference literature for developing questions in AIM practices and performance management comes from research papers in operation, and maintenance and performance management (e.g. Murthy *et al.*, 2002; Tsang, 2002; Al-Turki, 2011; Parida *et al.*, 2015), while questions related to AIM SP were based on previous research in the petroleum industry (e.g. Casertano, 2013; Grant, 2003; Mitchell and Mitchell, 2014) and several classic works in SP (e.g. Steiner, 1979; Hax and Majluf, 1984; Capon *et al.*, 1987; Miller and Cardinal, 1994; Mintzberg, 1994; Haines, 2000).

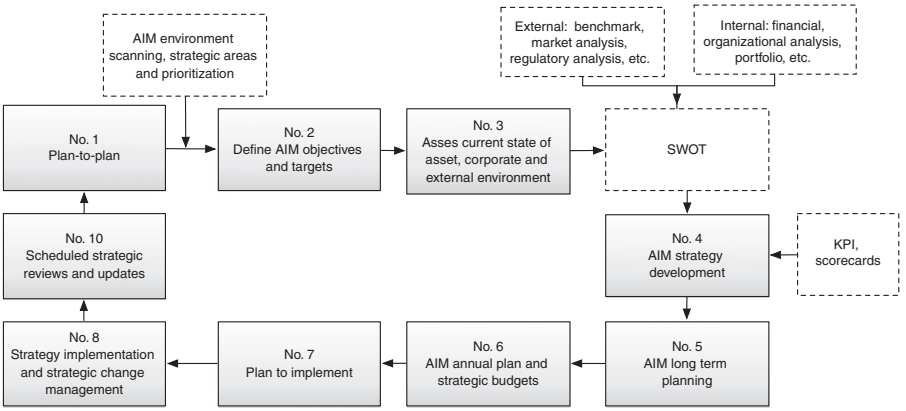


Figure 4.
Initial AIM strategic planning model (adapted from Haines, 2000, p. 50)

The results from the questionnaire were analyzed for trend and some variables were ranked according to the responses. Notes taken during face-to-face semi-structured interviews were summarized immediately after each interview and sent back to the respondents for validation of content. Additionally, some of the respondents also provided access to company documents to support the interview data. The interview results and the supporting data from each organization were analyzed to distinguish some of the key variables that later on were collectively analyzed with the results from other organizations.

Findings

Although the interview questions are the same for all the respondents, the quantity of information received from the respondents varies from one to another, depending on the confidentiality level of the organizations in which the respondents work. The questionnaire provided preliminary data of the organization and several scalable parameters that are related to the interview questions. The questionnaire data were analyzed in conjunction with the data gathered from the interviews. The analysis showed that there were several key variables that can be related to the formulation of AIM SP in the petroleum industry.

AIM SP practices overview

All of the respondents agreed that, ideally, an AIM strategy should be established early in the life cycle of a petroleum installation. The reasons are mainly attributed to sustainability, to implementation of a strong foundation in AIM before operation and to the greater requirement of time and resources if AIM is established later in the installation's life cycle. The latter has become one of the main challenges for smaller organizations wishing to apply AIM SP, as most of the smaller organizations have smaller fleets and less capital. The cost of establishing AIM early in a petroleum project is reported to range from USD 10 million up to USD 21 million on project sizes of USD 900 million-1.45 billion (Smith *et al.*, 2002); these figures could be higher when the work is performed after the asset has begun to operate.

For example, the respondents from smaller companies implement maintenance and operations management with accordance to class rules and regulatory compliance, depending on the country where the facility is operating. However, asset integrity is not very well-defined and -planned over the entire organizations. For example, the company might be based in Norway but they have fleets operating in the Asia or Africa regions where the regulatory regarding AIM is not as strict as in Norway. With these considerations, plus other factors such as remaining life, contract terms, etc., it might not be profitable to imply full AIM requirements in their aging facilities.

From the interviews, it was observed that companies see AIM SP more as mid-term planning (five to ten years), which can be adjusted yearly by tactical plans (one to two years). The application of yearly tactical plans is a form of continuous improvement in SP. Additionally, one of the respondents expressed the importance of documenting all steps in the planning process for future reference.

From the questionnaire it was also found that the smaller size organizations have neither established formal AIM SP nor put a similar process in place. The larger organizations have implemented more decentralized SP processes since the 1990s, while the smaller organizations are planning to establish such formal processes in accordance with the growth of their organizational size. The respondents from smaller organizations see that AIM SP is a form of organizational alignment and perceive that it is still not needed in an organization their size. These organizations perform AIM SP at the beginning of an asset's life cycle with long-term duration between 20 and 30 years. This is not normally updated until the asset is modified, decommissioned or changes owners.

In larger-size organizations, the formal AIM SP processes are performed every three to five years and more tactical planning, in a yearly or two-yearly cycle. Studies and analysis to produce forecasts or strategic business reviews would initiate the SP cycle, followed by the issuance of a corporate strategic plan and guidelines from the corporate management and additional input from stakeholder requirements.

The mid-managerial divisions may adjust forecasting and guidelines accordingly to fit the business units' specialization. For example, in one of the respondent's organization, the corporate objective was to optimize overall efficiency in the organization; the divisional management then set a goal for a 25 percent increase in production efficiency and a further 25 percent in process and manpower efficiency. Then AIM planning will be drafted from the bottom-up, starting from the business units.

The corporate guidelines would pertain to environment scanning and business forecasts, possible scenarios, general objectives and an outline for the strategy, while the stakeholder requirements might be related to client, government or class requirements. Moreover, there are additional requirements that are unique to the asset, discipline or geographical area, for example, class requirements or the country's specific standards. Other factors that were considered as input for AIM strategy are previous performance reviews (e.g. asset, strategy, resources, financial), challenges and opportunities, technology and innovation, support services, HSSEQ (health, safety, environment, safety and quality) records, operating expenditure (OPEX) records, benchmarks, etc.

Since AIM involves multi-disciplinary subjects, there are several different disciplines that are integrated in the process, such as operation, maintenance, operation support, engineering, supply chain, etc. According to two of the respondents, in their organizations there will be a vocal point that coordinates the input between different disciplines and holds meetings between these disciplines.

Based on available guidelines, the business units responsible for AIM will then perform an internal SP process to formulate a strategy and suggest KPIs for performance evaluation. The respondents from larger companies reported that the business units also conduct environment scanning or strengths, weaknesses, opportunities and threats (SWOT) analysis to address their focus area accordingly. One of the respondents believes that all related factors are important for asset integrity, but it is challenging to address them all at the same time due to time and budget restrictions. Thus the environment scanning would prioritize these factors and allocate resources to the most vital. The SP drafts will be evaluated from the bottom-up and revised accordingly to regulate OPEX and other budgets until the committee board approves it. This process is in illustrated in Figure 5.

Compared to previous top-down practices, the respondents consider that it is much more reasonable if the business units are given more freedom in deciding which strategy they will take.

Content and performance management

According to the respondents, the content of an AIM strategy outlines how the business units will uphold the asset's desired integrity level and how the asset will contribute to the organizational objectives. The AIM SP would be an integration of inputs from several related disciplines and clearly outline how to implement, monitor and review the strategies related to the AIM activities, for example, maintenance strategy and replacement strategy for different equipment types, production strategy related to topside and reservoir, manpower and training strategies, etc. Compared to implementation planning, AIM SP would give a more general direction and fewer details on activities.

The practices in the respondents' organizations are vary, depending on their organizational structure. On the smaller organization, this practice can be as simple as assigning a coordinator that responsible for AIM for their facilities. Others with more complex organizational structures are appointing coordinators from each department to ensure the input and implementation into the integration process.

When submitting the draft for the strategy, business units also suggest a set of KPIs, which the corporate management will review and revise accordingly. The corporate management has normally set a performance indicator related to the organizational objectives; the final performance indicators would be agreed between corporate management and business units. Generally the respondents stated that the focus of the performance review would mainly cover financial performance (OPEX), HSSEQ performance, technical asset performance (e.g. integrity, production, downtime, maintenance backlog, etc.) and human performance. The specific targets and indicators are determined and agreed beforehand.

Most of the respondents agree that AIM SP needs to be periodically reviewed to adapt to the changing environment in the petroleum industry. With the fluctuating oil price, organizations need to be more adaptable and more responsive to changes. In yearly planning, one of the respondents claimed that the asset's performance is reviewed quarterly with an automated AIM system, while others range from every six months to a year.

A quarterly review, according to one of the respondents, allows the business units to make strategic decisions in response to current situations. Two other respondents argued that a quarterly review requires more resources and time. The other respondent for smaller organizations also reasoned that to employ AIM software for a quarterly review would be ineffective spending compared to the size of the organization. Instead, the smaller organizations outsource the performance measurement activities through a third party, such as through class inspections or other service providers. It was noted, however, that these smaller companies were outsourcing their AIM activities but not their AIM core competences. For example, one of the companies outsource their inspection activities and the analysis of findings to a service company without giving authority for decision-making outside of their scope. The company entrust this working process and the decision-making function to the internal supervisor or engineer.

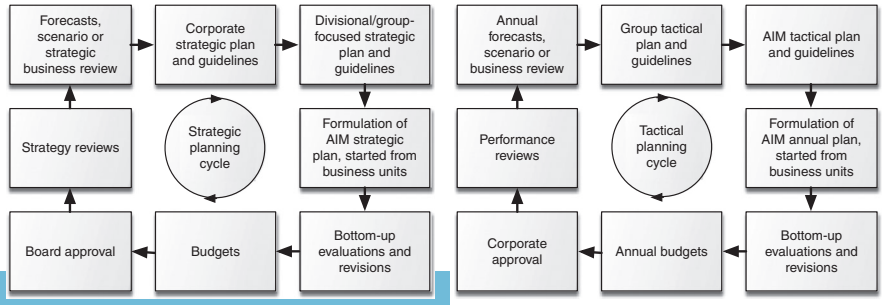


Figure 5.
Typical AIM strategic and tactical planning cycle

Environment scanning, risk-management and the strategic areas

Four of the respondents agreed that any planning process should begin with an assessment of the asset's business environments, which consist of the organization's internal and external environments. This part of the process is generally known as environment scanning, although the respondents' organizations use different terms and techniques such as strategic analysis, SWOT, benchmarking, portfolio analysis, etc.

From the environment scanning, organizations would try to estimate future consequences and determine which area to focus on in the planning. These areas of focus are also called strategic areas or strategic dimensions (Tsang, 2002). According to one of the respondents, strategic areas could vary from one term to another. It would depend on the result of environment scanning and the guidelines from corporate management. According to one of the respondents, almost every factor is significant for AIM; however, issues need to be prioritized and addressed accordingly. In addition, scenario planning is also presented in two of the respondents' organizations, which they think is especially useful in the fluctuating situation of the petroleum industry.

In the interviews, four of the respondents stated that, due to the certain risks they carry, AIM planning for petroleum assets involves prioritizing risk-management and performance management. The ISO standard 55002:2014 also prescribes a risk-management approach for planning physical AM, alongside other organizational objectives. Additionally, one of the respondents claimed that nowadays it is common for the new-built assets to adopt a life cycle approach for their AIM planning. Life cycle analysis would provide further coverage in the integrity planning of the facility, extending beyond the organization's responsibility period.

In the operations phase, a continuous AIM effort needs to be sustained at all times. The result was apparent, since one of the respondents declared that, even after the life extension assessment, most of their facilities do not require extensive modifications; this is due to the continuous effort expended in maintaining the facility´s integrity. This approach will be useful in cases beyond the expected responsibility period such as life extension, conversion and trade or decommissioning.

One of the respondents also gave the reason that SP is basically the organization's attempt to optimize their competitive advantages against possible threats, by forecasting and managing their potentials and weaknesses. This concept is similar to Figure 1 on balancing the different AIM areas. The respondent also added that, in addition to forecasts, petroleum assets are also being prepared against unforeseen circumstances through emergency preparedness planning. The unforeseen circumstances could be accidents, incidents, security threats, hijacking, severe weather, fire and explosion, etc.

The planning structure

Since most of the respondents' organizations chose to withhold their strategy planning documents, the interviews took place so that the respondents could explain the process verbally and compare their practices against an AIM SP structure presented in Figure 4. From their responses, all of the respondents agree that the model is applicable and that their organizations have similar processes in practice. The smaller organizations, however, are limited in terms of the allocation of resources and budget, thus seeing AIM SP as mid-term or long-term planning. Instead, they adjusted their budgeting (OPEX) every one to two years and their tactical objectives when necessary.

The biggest change that was suggested to Figure 4 was to clearly distinguish between the corporation's and the business unit's processes. Corporate also tend to have static objectives (static targets) in their guidelines, thus the business unit need to further specify their objectives and performance indicators. Another suggestion is to change the term "annual plan" into "tactical plan," since the period could vary for different organizations. These changes were incorporated into a new structure, as shown in Figure 6.

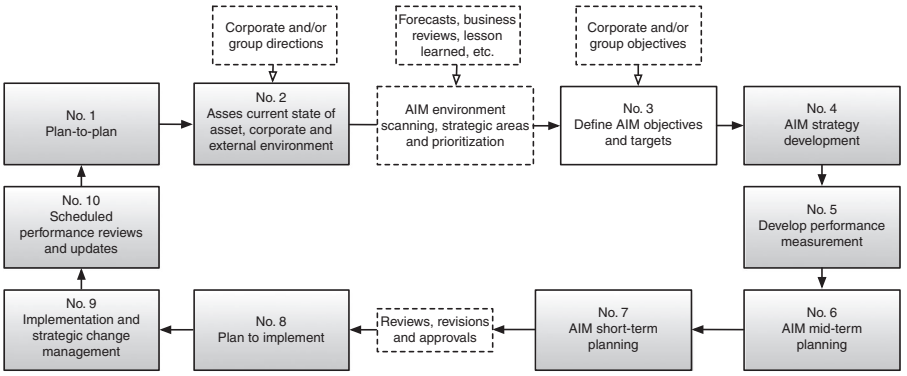


Figure 6.
Revised AIM strategic planning model

Although it may be known by different terms in other organizations, "environment scanning" is still a fundamental step in initiating the AIM planning process. Moreover, AIM possesses unique potential and traits due to the multi-discipline nature and its position between corporate business and direct connection to the asset. Prioritization is also a part of environment scanning, which gives significance to the more imperative subjects for resource allocation.

It was also noted that the larger organizations were restructuring their AIM processes; this was one of their recent SP objectives. Efficiency is especially promoted in the corporate strategic plan. This was mainly due to the fluctuating oil price since 2014. One of the respondents claims that they have recorded a significant increase of 90 percent in production efficiency in one of their liquefied natural gas facilities. Despite the fluctuating oil price, all of the respondents agreed that the integrity of the asset would not be compromised.

Discussion

From the findings, it was observed that AIM SP practices vary between different organizations. The larger the organization is, the more available are the resources and budget to be allocated in SP. Moreover, as a multi-discipline subject, AIM SP involves several business units in the organizations, and all elements are significant in reaching objectives. This statement is opposed to Visser (1998), who views maintenance as the heart of enterprise and hence it should have its own strategic plan. Instead, the findings suggested integration between business units in the organization to reach AIM objectives. This includes integration between, for example, operations, maintenance, production, engineering, supply chain, supports, etc. Consequently, AIM has multiple focus areas, which, according to the respondents, are mostly significant and reliant on one another. These focus areas are analyzed and given prioritization in the planning, due to the limited allocation of resources and budget.

Another factor that will affect the focus areas are the internal and external environments of the organization, such as fluctuating market, competitors, innovation and technology, stakeholders, incidents and accidents, country/region, regulations, etc. This means that these focus areas can vary and are naturally dynamic instead of static. Therefore, to focus on specific areas statically is not a favorable trait in SP, as also suggested by Mintzberg (1994). In contradiction, Tsang (2002) suggested four strategic dimensions in maintenance management. Maintenance is an inseparable part of AIM, thus the notion of static strategic dimension is not in agreement with this study's findings.

Another finding is in line with Grant (2003), who also observed that the AIM planning process is a semi-controlled bottom-up process, where business units are given some degree

of freedom in establishing their strategies and performance indicators. Performance management has become a part of the SP process as a monitoring tool and an indicator of the success rate of their plans. Performance management has been acknowledged as a business tool to assess the quality and effectiveness of maintenance, and it would have a similar application in AIM (Parida *et al.*, 2015; Ben-Daya and Duffuaa, 1995).

It was also noted that, despite outsourcing of some AIM activities, none of the organizations was outsourcing their AIM management and planning activities. Since SP is meant to secure an organization's competitive advantage, this is in line with (Moreno-Trejo and Markeset, 2012), who suggested that organizations should keep their core competencies in-house.

Concluding remarks

In the initial part of the paper, it was concluded that organizations were performing SP to secure their competitive advantage for as long as possible; thus forecasts were made to direct the allocation of resources on certain focus areas. From the discussion, it was apparent that the focus areas are dynamic and depends on internal and external factors such as size of the organizations, assets, available resources and budgets, country or region, regulations, etc. Therefore, environmental scanning or other types of assessment for the asset's business environments, is an important step prior to SP formulation.

This paper has also summarized the findings in a study of AIM SP in the petroleum industry. It was observed that the practices of AIM SP vary amongst different organizations, hence mainly depending on the organization's size and the ability to allocate resources and budget. There were different terms of the AIM SP cycle: long-term planning that lasts for the life expectancy of the asset (20-30 years), mid-term planning, which ranges from five to ten years and shorter-term, ranging from one to two years. The intention of the different terms is for the organization to be more adaptive to the fluctuating conditions of the petroleum industry. Performance management also plays an important part in AIM SP, both as business and technical indicators of the strategy's quality and effectiveness. Moreover, the performance review feeds the continuous improvements loop in the SP process and acts as a catalyst for change management.

An updated structure of AIM SP is given in Figure 6, which was the result of discussions with respondents. The new structure suggested a generic practice in AIM business units, bearing in mind that this process is a continuation from the corporate SP process. In the structure, environment scanning or other forms of business assessment for the asset is considered as an important initiation step in the strategy-making process. It was also observed that environment scanning for AIM is a process that is unique due to the AIM business and technical traits. Thus, for future study, it will be advantageous to study the process of AIM environment scanning.

This paper also pointed out the integration of different disciplines in AIM SP; however, the limited study time did not allow further research into the integration mechanism. A further study on the integration and coordination mechanism in AIM would be advantageous, considering that this is one of the main reasons that AIM practices are unsuccessful.

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