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Operations Management and Sustainability in the Energy Industry

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ABSTRACT
Creating environmentally sustainable operations without significantly increasing operating costs is a massive challenge for national energy industries. This research found that the Australian energy industry had operational objectives of output control, environmental impact, quality control and cost control. Sustainability objectives were reduced carbon emissions, energy consumption and associated resource consumption. Eighty percent of respondents indicated that compliance with regulations was the most important reason for being environmentally sustainable and the industry did not seek to be a leader in sustainability. Current sustainability control systems were most frequently identified as predictive and reactive, controlling, continuous and (to a lesser extent) technology based. Operations management practices were most frequently identified as activity-based costing, inventory management and quality control. An opportunity exists to use technology management to improve sustainability performance because of the current reactive approach to the use of technology in the industry’s sustainability operations management.

INTRODUCTION
Creating sustainable energy generation operations has been identified as a major challenge globally (Kaygusuz, 2007). The Australian energy industry is one of the highest contributors of greenhouse gases per head of population (World Trade, 2008). This industry has a major challenge meeting Australia’s commitment to the Kyoto protocol, whilst maintaining costs at reasonable levels. The creation of sustainable operations in the energy industry involves technology and integration with other process operations. Its cost effective implementation can be viewed as an operations management objective. Therefore, it is appropriate to examine the operations management context for sustainable energy generation in Australia. This paper reports on the findings of a survey conducted with all Australian energy industry generators, energy retailers and energy industry consultants. The paper identifies the industry’s operations and sustainability objectives, approaches they currently utilising and the barriers to experiencing in establishing sustainable operations. The frameworks for this analysis are key decision areas/competitive priorities (Hayes & Schmenner, 1978), order winning versus order qualifying criteria (Hill, 1995b) and Miles and Snow’s (1978) classification of technology approaches. A copy of the questionnaire is available from the author.

LITERATURE REVIEW
An important area of sustainability for the energy industry is the sustainability of the mining processes that provide the energy inputs (D'Esposito, 2000). Delivery reliability is also an important factor (Desiderio, 1999), which requires capabilities in production and planning. They can also be improved by shortening the supply chain, which has the added advantages of improving quality and reducing costs by reducing administration and simplifying overall processes. Typical supply chains in the energy industry include mines, transporters, equipment construction and maintenance, energy retailers and agents. Other important factors include management of material and energy flows and operations control to minimise environmental impact (Basu, 2006).
The strong relationship between the organisation's environmental conditions and the Competitive Priorities (CPs), which create a competitive advantage (Boyer, 2002), mean that there may be a high level of consistency in CPs across industries experiencing the same environmental conditions (Fine & Hax, 1985; Wheelwright & Hayes, 1985). In an industry such as the energy industry, the extensive use of energy in industrial societies and the medium levels of industry rivalry (IBIS World, 2008) suggests that the most commonly applicable CPs such as cost, quality, delivery and supply flexibility (Orr, 1995) would apply. These CPs would lead to a focus on improving operations to reduce costs (including inventory levels); product and service quality development; creating flexible production plans; reducing delivery times and innovation in products, services and production processes (Garvin, 1987).

A focus on the Key Decision Areas (KDAs) which are the principal operations choices the organisation can make, in production process control, capacity, technology, planning and control generally improves performance in CPs, such as cost and quality (Boyer, 2002). Quality control/assurance, top management involvement, communication and product design KDAs can also influence CPs of cost, quality, reliability and innovation (Orr, 1995). Additional KDAs of production volume, sources, specifications, availability, geographical location, distribution channel, lead-times, standardization and handling are likely to contribute to CPs, such as cost and supply dependability (Hayes & Schmenner, 1978; Hayes & Wheelwright, 1979).

Operations strategy (the strategic use of KDAs to improve CP performance in support of corporate strategy) (Hill, 1995a) is a logical fit with the energy industry because of its long-term planning perspective (changes to products, capacity and supply characteristics take many years in this industry) (Hayes, 1994; Porter, 1996; Hayes, 1998) and attention to the effective management of valuable resources (energy sources, equipment and distribution networks). The consolidation which has occurred in the energy industry, which is the apparent result of a desire to be dominant in the industry, fits well with the operations strategy objective of achieving a "unique positioning of a company in the market" (Hill, 1995b). The effectiveness of an operations strategy is generally determined by the degree of consistency between CPs and corresponding KDAs (Leong, 1990). The difficulties the energy industry faces, however, is in identifying which KDAs apply to which CPs, the relative contribution a KDA can make to a given CP, the interactivity between KDAs and CPs (Rusjan, 2005) and the competition for attention from other aspects of the organisation due to ownership, regulation, historical behaviours and culture.

The difference between order winners and qualifiers (Basu, 2006) is also an important operations management concept for the energy industry, because of the high level of regulation it experiences (Basu, 2006). In this mature industry, competitive priorities such as price are ‘order qualifiers’, but priorities such as levels of service will be ‘order winners’ (Größler, 2007).

Because of the industry’s heavy use of technology, operations strategy and technology typologies provide a good approach for incorporating the external and internal technology conditions when reviewing the energy industry’s behaviour. Ward et al’s (1996) taxonomy categories of niche differentiator, broad differentiator, cost leader and lean competitor particularly appropriate for the energy industry, which aims to be a cost leader (IBIS World, 2008). Technology and internal resources can drive companies into the strategic approaches of being defenders, analysers, prospectors or reactors (least desirable) (Miles et al., 1978). The energy industry operates as a reactor in relation to sustainability (Davidson, 2005). Specific technology management approaches; however, such as traditional, moderate, high investment or specific application only does not appear to affect company performance on their own (Boyer, 1997).
These perspectives were used to develop the following hypotheses for the project:
1. KDAs associated with normally important CPs, such as cost and quality, will also improve performance in the CPs of sustainability.
2. The energy industry is dependent on technology to achieve its sustainability objectives.
3. The energy industry does not seek a leadership position in sustainable operations and so focuses on order qualifying criteria.
4. The energy industry fits into the traditional technology user category in relation to sustainable operations.

METHODOLOGY
The sample was constructed from searches in a business database (“Australia on Disc”) supplemented by extensive manual online searches. A total of 391 addresses were identified in the following categories; Consultant, Generator and Distributor. Respondents were sent a letter inviting them to participate in a Web-based survey (survey took 5 minutes to complete). The survey questions (available from the author on request) were constructed using the operations management frameworks described above and the sustainability operationalisation issues identified in the literature. Where possible, invitation letters were sent to a named individual. The response rate was very low – only 5% in total; energy generators (22%), consultants (7%) and distributors (0%). The small number of response precluded exploratory statistical analyses, so findings have been represented as percentages or averages. Because of this bias, the findings will predominantly reflect the views of energy generators (response rate for generators and consultants only was 9%).

FINDINGS
Performance objectives for energy industry operations
The participants identified [scale 1-5 with 5 most important] the most important operations objectives to be output control (ave. rating 4.7), raw materials supply control (4.5), environmental impact (4.4), quality control (4.3) and cost control (4.2). The most important objectives for sustainability identified were reduce carbon emissions (4.5), reduce input energy consumption (4.6), reduce consumption of associated resources (4.0) and produce fewer noncarbon pollutants (3.9).

The participants rated [scale 1-3 with 3 being high] the energy industry’s performance against these sustainability objectives as being best in reducing consumption of associated resources (ave. rating 2.2), reduce impact on natural landscape (2.2 – this objective was given a low importance rating as an objective), recycling of waste materials and products (2.1 – also given a low importance rating as an objective) and reduce input energy consumption (2.0).

Drivers for sustainable operations
Seventy-one percent of responding (generator only) participants indicated that they had specific environmentally sustainable operations objectives. Eighty percent of responding (generator only) participants indicated that complying with regulations was the most important reason for being environmentally sustainable and 20% indicated that minimising environmental impact was the most important reason. One hundred percent of responding (generator only) participants indicated that being a leader in sustainable energy was the least important reason for environmentally sustainable operations.

Participants identified reducing input energy consumption (96% of respondents), reducing carbon emissions (90%), reducing consumption of associated resources (81%) and producing fewer non-carbon pollutants (80%) as being the most important objectives necessary to be environmentally responsible. The respondents (both generators and consultants) provided an identical ranking for the objectives necessary to be environmentally responsible and the
objectives necessary to be a sustainable operations industry leader. This indicates that they do not differentiate between order qualifiers (objectives necessary to be environmentally responsible) and order winners (objectives necessary to be a sustainability leader).

The participants identified the most important barriers to sustainable operations as general budget limitations (73%), conflict with other operations objectives (63%), low strategic priority for sustainable operations (55%) and sustainable operations budget limitations (47%).

**Current approaches for controlling sustainable operations**

The participants identified their sustainable operations control systems as being mainly predictive and reactive (26%), monitoring and control (24%), continuous (20%) and technology-based (15%). The participants claimed [scale 1-3 with 3 being high functionality] that all of these functioned reasonably well -- monitoring and control (2.0) continuous (1.9), predictive and reactive (1.8) and technology based (2.1).

By comparison, the most common operations management practices in the industry were activity-based costing (83%), raw materials inventory management (72%) and quality control/management (65%). Forty-three percent of respondents (generators) claimed that their current sustainable operation systems were integrated with other operations systems and 57% claimed that they operated independently and in parallel with other operations systems.

**DISCUSSION**

KDAs associated with normally important CPs, such as cost and quality, will also improve performance in the CPs of sustainability. The literature notes that these KDAs include production process control, capacity, technology, planning and control, (Boyer, 2002), quality control/assurance, top management involvement, communication and product design (Orr, 1995). The performance objectives for the industry included quality and cost control in the five most important objectives. Important company specific objectives for sustainability included reducing consumption of associated resources and energy input which could be considered to be cost focused objectives. In addition, reducing input energy and associated resource consumption were also both considered to be important objectives for an organisation to be environmentally responsible and the sustainability leader. This suggests that cost and quality were important CPs for the industry (both in regards to sustainability and general business objectives).

Popular control systems in place in the industry identified included cost control (activity-based costing) and quality control/management. This suggests that cost control and quality control were industry KDAs. The high rates of importance for the CPs of cost and quality and high frequency identification of KDAs of cost control and quality control implies a relationship between the CPs of cost and quality for sustainability and the KDAs of cost control and quality control/management. No evidence was identified linking the KDAs of production, capacity, technology, planning control, top management involvement communication and product design with the CPs of cost and quality in regards to sustainability in the energy industry. This hypothesis was partially supported.

The energy industry is dependent on technology to achieve its sustainability objectives. Only 15% of the total participants identified technology as a factor for sustainability operations control. This suggests that technology is not used extensively in the industry as a sustainable operations control (in fact, 0% of the responding consultants indicated that technology was used a control for sustainable operations in the energy industry). As the energy industry is a process industry, it can be concluded that there may be significant potential to improve sustainability through the use of more advanced technology. The industry’s slow adaptation of technological change (IBIS World, 2008) suggests that a technology gap may indeed exist in this area. This hypothesis was not supported.
The energy industry does not seek a leadership position in sustainable operations and so focuses on order qualifying criteria. The finding that the energy industry did not differentiate between order winning and order qualifying criteria in relation to environmental sustainability, together with the finding that 80% of the (generator only) participants’ principal objective was to meet regulatory requirements, indicates that the industry is not seeking a sustainable operations leadership position and focuses on order qualifying criteria. This suggests that quality control type operations management practices would be the most suitable for cost-effective implementation of sustainability in the industry. This hypothesis was supported.

The energy industry fits into the traditional technology user category in relation to sustainable operations. The finding that only 15% of participants felt that technology was used as a control for sustainable operations together with predominant operations management focus on cost, quality and raw materials control (just in time and six sigma were identified by 35% and 18% of respondents respectively) suggests that the industry only uses technology for long-term proven uses, such as the basic operations process and not for recently emergent demands, such as creating sustainable operations — making it a traditional user (Boyer, 1997) of technology for this purpose. The medium rating for the effectiveness of these for creating sustainable operations identified (around 2.0 on a scale of 1-3) suggests becoming a high investor in technology management would provide an opportunity to improve sustainability in its operations. This change in technology management approach would increase the potential for technology to improve the sustainability performance of these organisations (Boyer, 1997). This hypothesis was supported.

CONCLUSION

Although response rates were low for this survey, some interesting findings have been identified. The Australian energy industry, despite facing significant demand for achieving cost-effective sustainable operations, has adopted an order qualifying and not an order winning view of managing sustainable operations. The industry’s CPs of cost and quality are supported by general operations KPAs of controlling cost and improving service and the sustainability KPAs of cost control (reducing consumption of inputs) and quality control (reducing emissions) and indicate that it is attempting to increase its sustainability whilst controlling costs. The identified barriers to creating sustainable operations of budget constraints and conflict with other activities, together with the low strategic priority for sustainable operations confirms the industry’s objectives of achieving sustainable operations cost effectively. The apparently limited (traditional) use of technology by the industry in sustainability operations control suggests that becoming a technology high investor in its operations sustainability may enable it to better achieve these objectives. The full reference list is available from the author on request.

SAMPLE OF REFERENCES (FULL LIST IS AVAILABLE FROM THE AUTHOR)


