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Achieving energy efficient ship operations under third party management: How do ship management models influence energy efficiency?

René Taudal Poulsen *, Henrik Sornn-Friese

Copenhagen Business School, Department of Innovation and Organizational Economics, Kilevej 14a, DK-2000 Frederiksberg, Denmark

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A B S T R A C T

Profitable energy saving measures are often not fully implemented in shipping, causing energy efficiency gaps. The paper identifies energy efficiency gaps in ship operations, and explores their causes. Lack of information on energy efficiency, lack of energy training at sea and onshore and lack of time to produce and provide reliable energy efficiency information cause energy efficiency gaps. The paper brings together the energy efficiency and ship management literatures, demonstrating how ship management models influence energy efficiency in ship operations. Achieving energy efficiency in ship operations is particularly challenging under third party ship management. Finally, the paper discusses management implications for shipping companies, which outsource ship management to third parties.

1. Introduction

Scholars have for a long time debated the extent to which energy efficiency gaps occur (Jaffe & Stavins, 1994), as well as what causes such gaps (Allcott & Greenstone, 2012; Bunse, Vodicka, Schönsleben, Brülhart, & Ernst, 2011; Jaffe & Stavins, 1994; Thollander & Palm, 2012; Sivill, Manninen, Hippinen, & Ahtila, 2013). Indeed, a rich body of literature has evolved, identifying barriers to energy efficiency (Trianni & Cagno, 2012). Barriers in this literature are all the factors that impede the adoption of cost effective, energy efficient technologies and practices or delay their diffusion (Fleiter, Worrell, & Eichhammer, 2011). The issue of achieving energy efficiency has received considerable attention from practitioners in the shipping industry. International shipping is highly energy intensive, with energy costs constituting up to 65% of voyage costs in 2012–13 (Lloyd's List's, 2012, 2013a, 2014a). Indeed, fuel efficiency came top of the list in a landmark survey carried out by the corporate law firm Norton Rose in 2013 (Lloyd's List's, 2013b).

Several recent studies have argued that a cost effective potential for fuel saving exists in shipping. Buhaug et al. (2009), Eide, Endresen, Skjong, Longva, and Alvik (2009), Eide, Longva, Hoffmann, Endresen, and Dalsøren (2011), and Faber, Behrends and Nelissen (2011) discussed various measures to reduce shipping's fuel consumption and argued that a wide range of options for increasing energy efficiency and reducing emissions by changing ship design and ship operation has been identified, but also that a considerable proportion of the potential abatement appears to be cost effective at present. Eide et al. (2011) followed along the same lines in calculating an average Marginal Abatement Cost Curve for shipping to assess the costs of averting the emission of one ton of CO_2 (which effectively means fuel saving). In addition, they identified several operational measures that could be implemented at net negative costs, including voyage execution, speed reduction, engine monitoring, trim optimization, and weather routing. These day-to-day measures directly concern ship operations, and require little or no investments. Faber et al. (2011) also identified several operational measures with fuel saving potential, and Crist (2012) summarized estimates of fuel saving potential in ship operations, which included such measures as reductions in port turn-around time, optimized voyage planning, trim optimization, autopilot optimization, and overall energy awareness in shipping organizations. All these studies indicate that the ship operation decisions made at sea and ashore on a daily basis can influence fuel consumption and cause energy efficiency gaps.

In this paper we are generally concerned with understanding the challenges of energy efficiency in shipping, and specifically concerned with addressing energy efficiency gaps in the context of different ship management models, i.e., whether shipping companies choose to either perform the tasks related to ship operation in-house or outsource them to independent companies. Regarding the latter, we follow the recent call of Johnson, Johansson, and Andersson (2014), who specifically

* Corresponding author.
E-mail addresses: rtp.ino@cbs.dk (R.T. Poulsen), hsf.ino@cbs.dk (H. Sornn-Friese).

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emphasized the need to study energy efficiency in shipping in the context of contract monitoring with respect to third parties.

1.1. Identifying barriers to energy efficiency

The United Nation's Intergovernmental Panel on Climate Change (IPCC) has identified four broad classes of barriers to energy efficiency, including lack of information, limited availability of capital, lack of skilled personnel, and other barriers (IPCC, 2011). A further attempt of classification was made by Sorrell et al. (2000), Sorrell, O'Malley, Schleich, and Scott (2004), and Sorrell, Mallett, and Nye (2011), who offered an economics based taxonomy, developed on the basis of categories that were widely highlighted in the energy efficiency literature, and founded on theoretical concepts and ideas from economics, behavioral perspectives, and organization theory. Specifically, they called attention to six major classes of barriers. First, perceived risk of energy saving investments owing, for example, to fluctuations in energy prices, may prevent firms from adopting energy saving measures, even if these would prove profitable in the longer term (see also Velthuijsen (1993)). Thus, risk aversion may be seen as a major barrier to energy efficiency.

Second, investment decisions are subject to imperfect information, which may explain why some cost-effective opportunities are being missed or why, in some cases, less efficient solutions may drive more efficient solutions out of the market. Indeed, Howarth and Andersson (1993) demonstrated theoretically how problems of imperfect information and transaction costs may bias rational decision-makers to invest in less energy saving measures than those that would be chosen by an informed social planner guided by the criterion of economic efficiency.

Third, there may be substantial hidden costs associated with investments in energy efficiency, such as, overhead costs for management, disruptions to production, staff replacement and training, or costs associated with collecting, analyzing and applying information.

Fourth, limited access to capital may prevent energy efficiency measures from being implemented, as decision-makers choose to pursue other more promising investment opportunities. A survey-based case study of barriers and drivers for energy efficiency in the Swedish foundry industry, for example, found that limited access to capital constitutes by far the largest barrier to energy efficiency closely followed by the risk of hidden costs, and especially the risk of production disruptions (Rohdin, Thollander, & Solding, 2007).

Fifth, there may be split incentives, or principal-agent problems, in which case energy efficiency opportunities are missed if the decision-maker cannot appropriate the benefits of the investment (Thollander & Palm, 2012; Vernon & Meier, 2012). Principal-agent problems may occur when two parties enter into a contract and have different goals and levels of information regarding energy saving potential. In the housing sector, for instance, landlords (as agent) may refrain from investments in energy saving measures, because savings would accrue to tenants (as principal), who pay for energy, but do not know about the saving potential. Or to reverse the argument, tenants (in this case with the role of agent) would refrain from energy savings if the landlord pays the energy bills (in this case with the role of the principal), and the landlord cannot monitor the energy consumption of the individual tenants (OECD/IEA, 2007).

Finally, bounded rationality is identified as an important barrier to energy efficiency. Decision-makers are limited by the information available to them, in their cognitive capacities and in the time available to make the decision and, hence, may neglect to pursue energy saving measures, even if they have the appropriate incentives to do so. Rather, decision-makers satisfice, basing their decisions on rule of thumb (Simon, 1957).

Sorrell et al. (2000) included the human dimension as a distinct category to be considered in addition to the categories discussed above, but they emphasized that this dimension is not readily amenable to formal modeling using the standardized tools of optimization theory. Studies of the human dimension have derived mainly from the psychological literature, and they have been framed as more general observations about the process of energy decision rather than as discrete barriers to energy efficiency. In addition, they have included only few empirical studies of energy decisions in organizations. Nevertheless, Sorrell et al. (2000) emphasized three concepts from this literature that could be framed in terms of energy efficiency gaps, including 1) the form in which decision information is presented (i.e., the extent to which it is specific and personalized, vivid, clear and simple, and close in time to the relevant decision, as well as including feedback to previous energy decisions); 2) credibility and trust in information exchange (emphasizing the importance of interpersonal contacts); and 3) inertia (i.e., decision-makers tend to rationalize previous decisions, emphasizing the positive aspects of the decision and the negative aspects of the alternatives that were not chosen).

Sorrell and colleagues organized the identified barriers to energy efficiency according to three theoretical perspectives, as summarized in Table 1. They stressed the conflicting underlying assumptions of those perspectives about the nature of human rationality and the role of market mechanisms, but they also argued for complementarity between them.

Various methods and frameworks have been applied in studies of energy efficiency in shipping. Johnson and Andersson (2014), Johnson, Johansson, Andersson, and Södahl (2013), Johnson (2013) and Johnson et al. (2014) applied action research methods. Johnson et al. (2014) identified five major barriers to energy efficiency in the shipping companies that they studied: Low level of project management maturity, difficulties measuring energy performance, fragmented responsibilities, lack of communication, and lack of knowledge and resources. Jafarzadeh and Utne (2014) developed a comprehensive framework for ship owners and managers to identify energy efficiency gaps, which included seven broad categories of barriers: Information, economic (such as hidden costs and lack of capital), intra-organizational (such as bounded rationality and inertia), inter-organizational (split incentives), technological (technical risks), policy (conflicting regulation), and geographical (related to shipping in areas with piracy etc.). Rehmatulla and Smith (2013) applied a survey methodology to identify barriers to the implementation of fuel saving initiatives and distinguished between organizational (culture and power), behavioral (bounded rationality, information problems, inertia and trust), and economic barriers (principal-agent problem, asymmetric information, hidden costs etc.) to energy efficiency. In a study of Norwegian shipping, Acciaro, Hoffmann, and Eide (2013) identified barriers for the implementation of cost saving technologies related to principal-agent problems. Finally, Agnolucci, Smith, and Rehmatulla (2014) examined to what extent energy efficiency is remunerated in the panamax, dry bulk time charter market and also found strong evidence that principal-agent problems are a main barrier to energy efficiency in shipping.

Table 1
A taxonomy of barriers to energy efficiency.

Perspective	Sub-division	Barrier
Economic	Rational behavior	Heterogeneity
		Hidden costs
		Risk
		Access to capital
	Market or organizational failure	Imperfect information
		Adverse selection
		Split incentives
		Principal-agent relationships
Behavioral	Bounded rationality	Bounded rationality
	The human dimension	Form of information
		Credibility and trust
		Inertia
		Values
Organization theory		Power
		Culture

Source: Adapted from Sorrell et al. (2000).

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