Business Strategy and the Environment
Bus. Strat. Env. **21**, 111–126 (2012)
Published online 27 June 2011 in Wiley Online Library
(wileyonlinelibrary.com) **DOI:** 10.1002/bse.718

Sustainable Development of Maritime Operations in Ports

John Dinwoodie,[1]* Sarah Tuck,[1] Harriet Knowles,[1] James Benhin[1] and Mark Sansom[2]
[1]*School of Management, University of Plymouth Business School, UK*
[2]*Falmouth Harbour Commissioners, UK*

ABSTRACT
Globalisation has heralded burgeoning ship movements and maritime operations in ports alongside increased international concerns regarding potential environmental impacts. In particular, smaller ports require accessible tools to manage them. A framework to facilitate environmental management applies business process principles to identify relevant inputs, processes and outputs. A case study of Falmouth Harbour Commissioners compares functional units and flows that define input–output processes for anchoring and bunkering operations. Strategic-level processes affect present and future operations while tactical service processes guarantee service level and quality through their integrity. Operational processes occur at the output level. An accessible generic framework supports planning of more sustainable maritime operations, facilitates mitigation of potential risks and encourages authorities to engage with sustainability agendas and manage development proposals proactively. Ongoing interlocution with business strategists will refocus port managers on educational and commercial missions and increase stakeholder engagement. Simplification and optimisation phases of business process re-engineering remain untapped by business strategists. Copyright © 2011 John Wiley & Sons, Ltd and ERP Environment.

Received 8 February 2011; revised 1 April 2011; accepted 11 April 2011

Keywords: business process framework; environmental management; smaller ports; sustainable development; maritime operations; stakeholder engagement

Introduction

Business strategists have studied environmental obligations in supply chains and multinational oil corporations (e.g. Shah, 2011; Chertow and Miyata, 2011; Sarkis *et al.*, 2010; Ketola, 2007; Miller and Quinn, 1998) but not port authorities, which oversee maritime operations including extensive oil loading and discharging. This paper proposes a business process framework to remedy this omission. Maritime operations span all routine procedures which a ship must undergo whilst in port to operate effectively, including anchoring, marine fuel bunkering and ballast water exchange. Specialist regulations, conventions and guidelines underpin each operation which may *inter alia* have an impact on environmental aspects including emissions to air,

*Correspondence to: John Dinwoodie, Head, International Shipping and Logistics Group, School of Management, Cookworthy Building, University of Plymouth Business School, Drake Circus, Plymouth PL4 8AA, UK. E-mail: jdinwoodie@plymouth.ac.uk

soil and sediments, discharges to water, noise, waste production, changes in terrestrial habitats and marine ecosystems, odour, resource consumption and port development on land or sea (Darbra *et al.*, 2005). Bunkering operations may engender oil spill risks with potentially catastrophic impacts on beaches, food chains, sediment and fishing communities (e.g. Edoho, 2008; Ray, 2008; Idemudia and Ite, 2006); anchoring may damage irreplaceable environments (Backhurst and Cole, 2000) and invasive species introduced during ballast water exchanges may upset delicate ecosystems (International Maritime Organisation, IMO, 2011). Currently, port authorities receive minimal practical support in discharging their responsibilities.

Typical of many industries, ports adopted a combination of awareness training and tougher regulation to bridge a gap between environmental aspirations and practice (Tilley, 1999). European Union (EU) Directive EC85/337 (later altered by EC97/11) advised ports to conduct an environmental audit which covers *inter alia* handling and storage areas of prescribed materials, waste emissions, spoil disposal areas, fishing, wetlands and zones of specific scientific or cultural interest, compliance with conventions and codes concerning marine pollution and dangerous goods, and prioritization of environmental protection issues. Audits are non-mandatory, but port managers are liable for environmental damages with consequent punitive damages. Each UK port authority is responsible for managing the risk of any potentially adverse environmental impacts caused by maritime operations within its aegis. The ports industry bears testament that effective implementation requires managerial involvement in the design process (Sroufe, 2003) as port authorities have willingly influenced environmental legislation through consultation, agreements which underpin guidelines and best practice, and assisted in developing benchmarks, management schemes, training, monitoring, research and collaborative involvement (Paipai, 1999).

A British Ports Association (BPA) environmental code of practice aims to raise environmental awareness amongst port employees and users. However, growing administrative pressures leave many port authorities reporting insufficient access to resources to help them meet current regulatory requirements (Royal Haskoning, 2009) fuelling risks of non-compliance or blind indifference (Hutchinson and Chaston, 1994; Wilson *et al.*, 2010). The UK government has promoted high environmental standards and supported sustainable port development (Department for Transport, DfT, 2000) but offers ports only statistical information, general guidelines, control on the development planning process and rules for project appraisal and commercial independence (Gilman, 2003). Port authorities undertake statutory duties to meet social and environmental obligations whilst embedding corporate social responsibility (CSR) concepts in port management systems and undertaking routine operations and development projects commercially (Pettit, 2008). Whilst definitions of CSR are probably socially constructed and idiographic (Dahlsrud, 2008), salutary failures within oil supply chains testify to the importance of corporate strategies being seen to canvas, understand and integrate community perceptions into CSR policies (Idemudia and Ite, 2006). Expert assessment of the 'significance' of potential impacts (Paipai, 1999) is not necessarily evaluated monetarily or quantitatively but developments that generate environmental concern are subject to environmental impact assessment (EIA) methodologies (Darbra *et al.*, 2005) to assess the potential impact on marine and terrestrial habitats (UNESCAP, 2009). Where assessments identify adverse impacts, mitigation requires management plans to conserve and protect public access to features of natural beauty or historic interest. Public bodies and port authorities prepare these for Sites of Special Scientific Interest (SSSIs; DfT, 2000). A qualitative scoping study is required if developments will impact *inter alia* on biodiversity or water (DfT, 2002).

Early work to assist ports to manage environmental risks and improve their performance engaged three Fal Estuary ports, which established a joint environmental management system (EMS; Paipai, 1999, p. 45; Falmouth Port, 2003). Later initiatives (EcoPorts, 2006) encouraged continuous improvement through implementing tools and methodologies to encourage better performance. The EcoPorts Foundation aims to help develop practical solutions for ports seeking to improve their environmental performance and to share knowledge and expertise (ESPO, 2003), although few smaller ports are members. Tools assist development of an environmental management and information system to plan and assess environmental issues, and to monitor compliance and assess impacts (Table 1). To assess the significance of maritime operations, the SOSEA tool (Darbra *et al.*, 2005) adopted a modified Leopold matrix (Leopold *et al.*, 1971). Rows list environmental aspects (see the first paragraph of the Introduction) and columns show activities. Activities include marine and coastal engineering, dredging, administration and planning, shipping and navigation and emergency situations by port authorities; cargo handling, storage, stakeholder activities, shipbuilding and repair, fisheries and port-based industry by port tenants; and bunkering, waste management, maintenance, land traffic and recreation and tourism by other tenants. In assessing the strategic perspective of each

DOI: 10.1002/bse

Initiative	Aims to:	Implementation	References
Self-diagnosis method (SDM)	Identify environmental risks and establish priorities for action and compliance	Port manager completes a checklist. EcoPorts guidance on benchmarking performance; analysis of strengths, weaknesses, opportunities and threats; strategic advice	Darbra *et al.* (2004)
Port environmental review system (PERS)	Assist ports to implement an environmental management system (EMS) through developing components within it to raise its effectiveness	Ecoports offer an independent review consisting of guidelines and example documents	Ecoports (2010; 2006)
Strategic overview of environmental aspects (SOSEA)	Identify 'significant' environmental aspects arising from operations; guide ports in gathering information to manage liabilities and responsibilities; enhance long-term strategic development and increase environmental awareness	Port indicates to Ecoports whether each of 12 environmental 'aspects' applies to activities which include bunkering, but not anchoring. An aspect is 'significant' if the number of ticks against it or a breach of legislation are 'significant'. For each significant aspect further questions on management and actions taken	Darbra *et al.* (2005)
ISO 14001	Promote continual improvements by encouraging ports to adopt and implement EMS; assist systematic development of a formalised management process, and evaluate effectiveness of activities, operations, products and services	Continuous monitoring improves understanding and assists risk management, supported by appropriate data collection techniques and record keeping	Darbra *et al.* (2009), Curkovic and Sroufe (2011)
Eco-management scheme and audit scheme (EMAS)	Promote ongoing improvements	Preparation of an environmental review and statement. See regulation EC1221/2009	IEMA (2010)
Associated British Ports	Identify environmental issues and associated risks; achieve scale economies	Multi-site applications of standardised procedures	Darbra *et al.* (2005, p. 867)

Table 1. Some tools to assist environmental management in ports

aspect, management must assess whether legal regulations (always significant), local-scale concerns of stakeholders or groups which require mitigation, global concerns relating to greenhouse effects, or other effects, apply.

This paper aims to present a framework to identify the business processes required to manage the potential environmental impact of maritime operations, particularly in smaller ports. It compares applications of an input–output systems framework to two maritime operations at strategic, tactical and operational levels by Falmouth Harbour Commissioners (FHC), and discusses the contribution of the framework and scope for further applications.

Framing Environmental Management Processes in Smaller Ports

Typically, organisational actions such as investing in equipment to mitigate pollution reflect decisions by managers, underpinned by an underlying sustainability strategy. However, the process of developing environmental awareness in ports (Peris-Mora *et al.*, 2005) and systems-based input–output modelling of port environmental management processes remain largely unexplored. In Europe's largest ports sector (Oxford Economics, 2009) few specialist environmental management tools are available to managers unless they join EcoPorts or employ personnel with environmental expertise, and a recent survey of 100 ports revealed 32 reporting ISO 14001 certification, with lower rates for other systems (Royal Haskoning, 2009). Certification is unlikely in the numerous ports not sampled, probably smaller authorities (DfT, 2006a). A staged process whereby environmental assessment and management is undertaken and owned by individual port authorities fosters local awareness and commitment most effectively (Paipai, 1999), but relatively few 'own' the issue, with 32% planning to outsource environmental management functions and a further 22% to recruit a specialist (Royal Haskoning, 2009). To assist in developing management awareness and reporting port environmental management processes, this paper presents a framework to identify relevant business processes.

Small and medium-sized enterprises (SMEs) typically view environmental measures as costly (Revell and Blackburn, 2007), requiring time to develop. However, potential cost savings, positive publicity or new customers attract some business owners (Revell *et al.*, 2010). To implement continuous environmental monitoring implies dedicated specialist personnel, typically unaffordable in smaller ports. Further, where managers feel a sense of environmental responsibility, this may be underplayed and their environmental awareness and commitment diminished if an EMS is managed externally. Effective frameworks to guide environmental management must be flexible and capable of accounting for heterogeneity (Vernon *et al.*, 2003). Policy makers' assumptions of a top-down diffusion of environmental initiatives may be inappropriate for SMEs (Baylis *et al.*, 1998).

One recent framework to assist comprehension of environmental management practices (Lucas, 2010) grew from interdisciplinary cross-fertilisation of ecological economics and strategic management. The framework presented here similarly innovatively integrates business process re-engineering and environmental management with influences from business strategy. Traditional physically based environmental assessments in ports require strategic physical and data inputs, but being uninformed by models of CSR strategy, they have typically shunned instrumental and political influences. Discarded branding and reputation-building motivators of corporate responsibility (Ditlev-Simonsen and Midttun, 2011) have implications for networking processes and external communication alongside political, integrative and managerial factors manifested in stakeholder management. Transitions in sustainability, typically framed within a supra-corporate social system (Loorbach *et al.*, 2010), imply important developmental governance inputs and consultation processes. Finally a commercial strategic input, perhaps via resource management, offers an economic dimension to support socio-cultural and environmental responsibilities in corporate sustainability (Ketola, 2010).

Derived from input–output process modelling, the systems framework includes three stages, or levels, comprising inputs, service processes and outputs. This established technique (Parnaby, 1979) aims to identify functional units and flows that shape processes in a company by defining the problem, system boundaries and function and variable flows. Management of the potential environmental impact of maritime operations in a port is conceived as a system involving various business processes. Lagoudis *et al.*, (2004, 58) defined a system as a 'group of interacting, interrelated, or interdependent elements, forming a complex whole', and a systems approach seeks to

DOI: 10.1002/bse

assist observation, understanding and analysis of the issues involved. This paper focuses on process mapping to understand and document environmental management.

To achieve the study goal, three levels of decision making are defined. Input–output process modelling identifies strategic inputs required to set up operations, analyses service processes that take place in everyday operations and then defines the operational output of these processes. At the strategic level, processes affect present and future operations and their potential impacts; tactical service processes ensure that service level and quality are guaranteed through the integrity of processes; and at output level, operational processes are defined. The various levels interact and the approach is holistic, as potential environmental impacts extend beyond the control of one port authority. Later, detailed analysis may specify where each action occurs, who is involved, when it takes place, why it occurs and how long it takes. An exploratory application (Dinwoodie *et al.*, 2009) to anchoring operations by FHC (Table 2) identified strategic decisions (S1–S7) to incorporate the overall determination of the system objectives, tactical decisions (T1–T7) to achieve the overall objectives and operational decisions (O1–O6) to keep the system within constraint limits and in accord with objectives. Some components may be revisited at different levels as when stakeholders are engaged at input (S4), process (T1, T3, T4) and output levels (O6).

Research Design

Carefully planned local responses to global pressures sometimes stimulate competitive advantages through collective action (Lund-Thomsen and Nadvi, 2010). Tougher supra-national regulation of marine bunker fuels heralded similar challenges for Falmouth, UK, a smaller port in an environmentally sensitive area. Enduring and intensified international concern regarding environmental pollution caused by traditional burning of low-grade heavy fuel oils with high sulphur contents in ships' bunkers prompted ongoing supra-national resolve and conventions to manage and reduce emissions. The IMO adopted regulations governing the Prevention of Air Pollution from Ships, Annex VI of MARPOL 73/78, in 1997. Reduced limits for the mass/mass of sulphur content for marine fuel oil consumed within designated sulphur emission control areas (SECA) adjoining densely populated regions, included North Sea, Baltic Sea and North American SECAs (IMO, 2011; Wang and Corbett, 2007). Within UK waters, 0.1% became the maximum permitted sulphur content of marine gas oils consumed (Directive 1999/32/EC; UK P&I Club, 2008a; AtoBviaC, 2010). Conveniently located adjacent to the 5° W SECA boundary, and offering extensive marine bunkering facilities, arrivals of large ships undertaking bunkering operations at Falmouth trebled (Table 3). FHC applications offer an extreme case context to test the business process framework in a very environmentally sensitive area which hosts bunkering operations at the UK's largest offshore terminal for marine oil and fuel, operated by a private commercial operator. FHC further regulates anchoring operations as a smaller port authority.

This growth prompted FHC to review how it managed the potential environmental impact of maritime operations, stimulating a knowledge transfer partnership (KTP) with a local university and funding of a maritime projects officer who worked with academics and managers to understand and document the business processes

Strategic level		Tactical level		Operational level	
Input		Service processes		Output	
S1	Mission statement	T1	Local familiarisation	O1	Internal monitoring, reporting, archiving
S2	Physical conditions	T2	Operational conventions	O2	External communication, dissemination
S3	Governance issues	T3	Networking	O3	Recommendations
S4	Stakeholders	T4	Consultation	O4	Mitigations
S5	Local data	T5	Reviewing, monitoring	O5	Sustainability
S6	Management system	T6	Hire expertise	O6	Awareness
S7	Resource assessment	T7	Reporting		

Table 2. Systems model overview

DOI: 10.1002/bse

Ship type	Year	Ship deadweight tonnage			
		Under 1 kt	5–19.999 kt	20–99.999 kt	Over 100 kt
Tankers	2005	66	53	112	27
	2008	77	162	363	70
Dry cargo	2005	82	83	58	21
	2008	104	207	368	20
Container	2005	1	0	3	0
	2008	6	44	21	0

Table 3. Number of ship arrivals at Falmouth (adapted from DfT, 2009; 2006b, Table 3.6)

required to meet environmental obligations. A framework was developed, tested and applied to anchoring and bunkering (Table 4), two very different maritime operations.

Case-based research strategies have been deployed to assess whether environmental certification may create competitive advantages (Curkovic and Sroufe 2011). This case study reports FHC oversight of contrasting maritime operations which vary in scale and type. If the framework can assist FHC it should be transferable to less environmentally sensitive settings. Similarly, although many larger ports already employ a specialist environmental officer, the framework might benefit them if it assists FHC to oversee its larger-scale bunkering operations. Successful application to two operations might imply a generic framework. With FHC as the case context and the framework as the phenomenon being examined, a case study research strategy centred on the case context allows the phenomenon being examined to remain embedded within its unique context (Dinwoodie and Xu, 2008).

EcoPorts and other initiatives typically focus primarily on physical environmental assessment. The systems framework's novel focus on business processes complements them, but is not directly comparable, and features potential environmental impacts rather than individual responsibilities or targets embedded in ISO 14001.

A Case Study: Falmouth Harbour Commissioners

As a case context offering *inter alia* safe anchoring and bunkering facilities for vessel of all sizes, Falmouth Harbour is located within the Fal Estuary in southwest England, a large international natural deepwater harbour. Adjacent facilities include dry dock facilities, cruise liner anchorage in Falmouth Bay and maritime services including shipbrokers, agents and chandlers (Falmouth Port, 2003). Urban development plans prioritize waterfront and harbour regeneration in a historic built environment and regional development plans prioritize environmental

Date	Event	Notes
August 2007	North Sea SECA introduced	
2007–08	Ship arrivals at Falmouth double	
Early 2008	FHC reviews EMS	3 months
March 2008	KTP proposal developed	6 months
October 2008	Maritime Projects Officer in post	
Late 2008	Understand and document business processes	3 months
December 2008	Systems framework developed	3 months
February 2009	Exploratory application of anchoring operations	6 months
April 2009	Application to bunkering operations	5 months
Late 2009 on	Ongoing refinement and application of framework	

Table 4. Research context and implementation
SECA, sulphur emission control area; FHC, Falmouth Harbour Commissioners; EMS, environmental management system; KTP, knowledge transfer partnership.

sustainability (Cornwall County Council, 2005) in a unique setting with a rich water ecosystem and valuable habitat. The bay and estuary incorporate Special Areas of Conservation (SAC) including maerl beds of calcified seaweed which may potentially be impacted by anchoring operations and SSSIs, Areas of Outstanding Natural Beauty (AONB), and Heritage Coasts.

A protected harbour accommodates bunkering operations (Falmouth Port, 2003) serving busy shipping lanes and bordering the 5° W SECA, re-designated ECA from July 2010, to embrace NO_2 and other emissions (IMO, 2011). The marine oil terminal bunkering operator Falmouth Oil Services Limited (FOS) offers all grades of fuels and lubricants to vessels and deliveries of gas oil and fresh water using barges, road tanks and pipes. FOS owns and operates a 50 kt shore-side bunker station which stores fuel for delivery to vessels anchored alongside or sheltering locally (Falmouth Port, 2003). FOS manages fuel deliveries, supported by a large independent bunker supplier and barge operator, which manages bunker sales. The oil terminal contains three tank farms, clean oil and fuel oil loading racks, slop reception and a processing facility. Two bunker barges service sales of fuel oil (FOS, 2009).

Four harbour authorities operate within the boundaries of the Fal Estuary and FHC manage a trust port, an independent statutory body controlled by an independent board and without shareholders or owners. By statute, FHC is required to proactively develop a sustainable approach to port operations and development opportunities and ensure that marine operations do not harm the valuable area (Falmouth Port, 2009). FHC have responsibility for areas where bunkering operations frequently take place (Falmouth Port, 2003; World Port Source, 2010, shows a map). All profits arising from commercial activities are reinvested in port development (Falmouth Port, 2007) and port management is open to public examination and responsible to interested stakeholders (DfT, 2000). Applicable safe standards are implemented through compliance with the Port Marine Safety Code (PMSC, Falmouth Port, 2009). FHC works with environmental agencies in accordance with UK environmental legislation and international conventions to maintain and improve the port environment. To conserve and enhance local environmental quality, staff education and training is undertaken and human activities which could cause negative impacts are guided by an environmental code of practice. Harbour authorities provide waste reception facilities. The EMS stows legislation and regulations notified by trade associations including BPA, EcoPorts, and government bodies. Records of all internal or external communications are kept, including complaints and environmental correspondence pertaining to port operations and commercial activities. If the impacts of operations are significant, consultants are appointed to audit and review activities or conduct an EIA. All targets and objectives comply with the PMSC and focus on mitigation and applicable safe standards (Falmouth Port, 2009).

Analysis

Strategic Inputs

For each prime strategic input (S1, S2, ...S7) Table 5 summarises sub-components of this input (e.g. i, ii, iii for S2) and notes any differences between anchoring and bunkering operations. The prime strategic input of FHC's mission statement (S1) applies to all maritime operations. It obliges 'a duty to work closely with environmental agencies.... [FHC is] ... committed to the protection and conservation of the environment ... strict adherence to UK environmental legislation and internationally agreed conventions.' Commitments to educate and train are noted below (Falmouth Port, 2009). FHC handle many physical conditions (S2) which include an AONB where 'development control decisions should favour conservation of the natural beauty of the landscape' (Cornwall AONB, 2010; S2i), avoidance of deterioration to habitats and disturbance to species (S2ii) which may potentially affect anchoring in maerl beds, and protection of the coastline from undesirable development (S2iii).

Strategies to manage governance inputs require port authorities to make contact, consult and comply with local authorities (S3i). At a national level, government and statutory inputs (S3ii) include the Environment Agency (UKEA) which seeks to protect and improve the environment, and via water framework directives to prevent deterioration in, and to restore, water quality. Inputs are likely from DfT; Department for Environment, Food and Rural Affairs (DEFRA); the Maritime Management Organisation which administers planning, licensing activities, marine nature conservation, public access to coastal areas and fisheries management; and Planning Acts which guide decisions on major infrastructure development, including harbours. Supranational inputs regulate bunkering

DOI: 10.1002/bse

Input		Port authority lists:	Does anchoring (A) differ from bunkering (B)?
S1	Mission statement	Its environmental obligations	No, but B engages FOS
S2	Physical conditions	Physical designations, e.g.	
(i)		AONB	No
(ii)		SAC	Maerl may affect A
(iii)		Heritage Coast	No
S3	Governance issues	Authorities it is answerable to	
(i)		Locally	No
(ii)		Nationally	B: Oil spill plans
(iii)		Supranationally	B: MARPOL, operating rules
S4	Stakeholders	Groups with an interest in its operations	
(i)		Marine agencies	No
(ii)		EIGs	No
(iii)		Suppliers	No
S5	Local data	Information available locally to	
(i)		Baseline port operations	A: locations; B: tide flows
(ii)		Baseline resource monitoring	A: AIS; B: buoys
S6	Management system	How activities will be monitored through	
(i)		An EMS	No
(ii)		Benchmarking	No
(iii)		Professional bodies	More conventions for B
S7	Resource assessment	How it will acquire and manage funding of assessments	No

Table 5. Strategic level inputs
FOS, Falmouth Oil Services Limited; AONB, area of outstanding natural beauty; SAC, special areas of conservation; EIG, environmental interest group; AIS, automatic identification system; EMS, environmental management system.

operations (S3iii) including: codes of practice to facilitate sustainability (ESPO, 2003); conventions underpinning transport, handling and storage of dangerous substances in ports (IMO, 2011); dumping at sea and protection of the maritime environment from oil pollution (Paipai, 1999). Currently, anchoring operations are less regulated.

In managing anchoring and bunkering operations, inputs to engage stakeholders are essential. Agencies (S4i) include Cornwall Sea Fisheries which maintain a flexible patrol service and sustainable fishery. Environmental interest groups (EIG, S4ii) include statutory bodies which promote sustainable development and volunteers including Friends of the Earth which aims to protect the rights of all people to live in a safe and healthy environment. Screening of suppliers and sub-contractors in building and maintenance works is an input (S4iii).

Strategic inputs to a port EMS require inputs of objectives and targets, and mapping and monitoring of local management systems. Reviews are required of baseline operations (S5i), resource monitoring of databanks, information retrieval, surveys, and recording systems. Data required to locate anchoring positions differ from inputs of tidal flows required by modelling software to predict oil spill movements which may potentially arise from bunkering operations (s5ii). Similarly, although the technology underpinning systems to collate automatic identification system (AIS) data to monitor the incidence of anchoring differs from local tidal flows recorded at buoys, similar actions are required to set up systems.

An EMS (S6i) to record legislation and technical data to drive continuous improvements in environmental quality and prevent pollution is one element of the strategic management system (Curkovic and Sroufe, 2011; ESPO, 2003). Others include communications with local authorities (S6ii) which detail requirements for EIAs, compliance with environmental issues embedded in local policies, plans and programmes (Paipai, 1999) and membership (S6iii) of EcoPorts and BPA which collaborate and contribute to establish best practice. Resource assessment (S7) is integral to FHC's mission of commercial viability and requires the costing and funding of all activities. Financial resources accrue from anchoring, piloting and other harbour charges, or government funding which includes KTPs with universities. All maritime operations are subject to this process.

DOI: 10.1002/bse

Tactical Level

FHC tactics to facilitate familiarisation include arranging visits (T1i, Table 6). Tours of anchoring operations include the harbour area, docks, pilotage facilities, moorings and FHC offices. Tours of bunkering operations visit tank farm, hoses, jetties and barges. Tactic T1ii similarly engages different types of shipping companies for each operation. Internal stakeholders (T1iii) include harbour authorities plus pilots for anchoring operations, and the bunker operator for bunkering operations. Action T1iv requires systems to record all operations and relevant data to enable FHC to identify any changes and the frequency of any environmental impacts. Anchoring operations entail arranging access to AIS data to reveal ship position, course and speed; bunkering operations entail acquiring and setting up buoys to host instrumentation to gather data to update tidal modelling and inform PISCES oil spill prediction software.

Bunkering operations are more regulated than anchoring and FHC requires procedures to guide those involved with supplying bunkers to ensure that operations minimise the risks of environmental damage (T2). Any implications for operational guidelines of anchoring in maerl beds will develop with ongoing research. Codes and conventions governing bunkering operations include:

- MARPOL, to prevent marine pollution caused through carrying or delivering oil products, vessel wastes and emissions, and control pollution involving noxious bulk liquids (IMO, 2011).

Service processes		Port authority plans:	Does anchoring (A) differ from bunkering (B)?	Duration A	Duration B	Days
T1	Local familiarisation	How to provide relevant information for those who need it using:				
(i)		Harbour visits	A: pilots, mooring; B: tanks	0.5	0.5	pa
(ii)		Researching client organizations	Shipping companies differ	0.5	0.5	pa
(iii)		Establishing stakeholder groups	e.g. A: pilots; B: FOS	1.5	0.0	pa
(iv)		Local monitoring technologies	A: AIS; B: PISCES	5.0	10.0	pa
T2	Operational conventions	What to comply with and how	B: More regulated	5.0	5.0	pa
T3	Networking	Who to contact and how through:				
(i)		Site visits to other ports	No, but ports visited differ	1.0	4.0	pa
(ii)		Relations with environmental agencies	No, but agencies differ	0.5	0.5	pa
(iii)		Stakeholder analysis	No, but contacts differ	5.0	5.0	pa
T4	Consultation	Who to consult and when including:				
(i)		Experts	No: experts differ	1.0	5.0	pa
(ii)		Professional bodies/ trade associations	No: bodies differ	2.0	4.0	pa
(iii)		Stakeholders	No: stakeholders differ	1.0	3.0	pa
T5	Reviewing, monitoring	Which data to gather, how, and how to analyse and store them including:				
(i)		Incident records	A: AIS; B: spills	1.5	4.0	pa
(ii)		Sampling operations	A: locations; B: incidents	1.0	2.0	pa
(iii)		Monitoring incidence and impact	No; more data for B	2.0	2.5	pi
(iv)		EMS/consumer satisfaction reporting	No	4.0	4.0	pi
T6	Hire expertise	Who to hire in and when including:				
(i)		Environmental consultants	No: experts differ	5.0	1.0	pi
(ii)		Public relations companies	No	2.0	2.0	pi
(iii)		Staff training	No	0.5	3.0	pi
(iv)		Client education and training	No: providers differ	5.0	10.0	pi
T7	Reporting	How to store incident/operations data	No: data or procedures differ	0.5	0.5	pi

Table 6. Service level processes and durations
FOS, Falmouth Oil Services Limited; AIS, automatic identification system; EMS, environmental management system; pa, [days] per annum; pi, [days] per incident.

DOI: 10.1002/bse

- SOLAS (safety of life at sea) which applies to ships involved in receiving and supplying fuel at sea relating *inter alia* to fire protection, safety navigation, carriage of dangerous goods and safety management (IMO, 2011).
- The design and construction of ships carrying liquefied gases and polluting bulk liquids.
- Minimum standards for the safe transport of dangerous and polluting goods by sea, and port operations in Europe (EU Directive 2002/59/EC; ESPO, 2003).
- UK Merchant Shipping (Ship-to-Ship Transfer) Regulations 2008 which govern transfers between ships, of cargo or bunker fuel involving hazardous substances in UK waters (Maritime and Coastguard Agency, MCA, 2008).
- Operating guidelines cover bunkering equipment, communication system, fire fighting, and pollution prevention equipment. Safety concerns include vessel condition, responsible personnel, quantity demanded and emergency plans (UK P&I Club, 2008b).

To establish networking (T3) requires tactical actions to instigate site visits and shared experiences with ports (T3i) that demonstrate best practice. Instigating regular meetings, email and telephone contact is required to develop relations with groups and agencies (T3ii) as is stakeholder analysis (T3iii) (Falmouth Port, 2009), and although contacts vary with the types of maritime operation, tactical actions are similar. Similar actions are required to establish consultation, engaging experts from universities and Natural England (T4i), and professional bodies and trade associations (T4ii) such as BPA to access advice on legal and policy issues, exchange knowledge and develop best practice. Established contacts in governmental or other agencies will email notifications or advertise meetings as new obligations arise. Ongoing stakeholder consultation (T4iii) requires updated contacts lists, stakeholder analysis, identification of contacts and communication to identify concerns.

To enable review and monitoring of impacts and any scope for simplifying operations, service processes require databases which detail procedures, the frequency of operations and any environmental impacts (T5i). FHC undertake proactive local oceanographic modelling of pollution incidents using GIS databases of hydrographic and tidal records to assist national and local emergency authorities to enact oil spill contingency plans (ESPO, 2003). Updating requires tactical decisions on how and where to sample (T5ii). In the case of anchoring, historical AIS records are interrogated. FHC cooperates with national and local authorities in preparing contingency plans for dealing with oil pollution incidents (IMO, 2011), promoting awareness of existing contingency plans, communicating this knowledge internally and assisting coordination of contingency plans and contributes to improve the safety of navigation and prevent pollution (ESPO, 2003). The UKPMSC requires all ports to carry out risk assessment for marine operations to implement the safety management system for managing navigation (Risk Support, 2001). This standard offers a framework for preparing policies and plans (Paipai, 1999; Falmouth Port, 2009). Heavy regulation requires more actions to establish monitoring systems (T5iii) and report key indicators and aspects of consumer satisfaction and the impacts of mitigations and monitoring (T5iv) for bunkering, than anchoring operations.

When hiring in expertise, processes facilitate actions T6i and T6ii, perhaps to publicise particular activities or manage media engagement surrounding maerl beds, oil spills or pollution incidents. Tactics to develop environmental awareness training for staff (T6iii) may encourage personnel to join trade associations, attend conferences or visit other ports to share best practice. To fulfil its mission to educate and train waterway users to be aware of their impact on the environment, FHC requires processes to engage specialist training providers for persons undertaking anchoring operations or using bunkering facilities (T6iv). Procedures are required (T7) to archive AIS records of anchoring operations and incidents arising during bunkering operations. Cumulatively, records log changing port activities (Paipai, 1999). These records inform the EMS, are available to authorities and stakeholders and are updated as legislation changes.

Table 6 reports either the approximate number of days spent per annum (pa) on regular activities such as networking and consultation or days spent per incident (pi) on *ad hoc* activities such as training for new staff or oil spill response. In general the duration of many service processes is similar for each operation, but tactic T1iii is transferred to the independent bunker operator. Because bunkering operations are complex, some activities (T3i, T4, T5, T6) require more time, dependent on the complexity of the analysis (T6i).

Operational Level

Increasingly, FHC monitors how far consumers are satisfied with how it manages environmental assessments. As an output process (Table 7) operational actions are well coordinated. A first operational action highlights

DOI: 10.1002/bse

	Output	Port authority will:	Do anchoring actions (A) differ from bunkering (B)?	Duration A	Duration B	Days
O1	Internal monitoring, reporting, archiving	Collect, record, present and store key data. Set up:				
(i)		Monitoring scheme	No; A less developed	1.0	2.0	pa
(ii)		Environmental library	No; A less developed	0.5	0.0	pi
(iii)		CSR reporting	No; A less developed	1.0	1.0	pa
O2	External communication and dissemination	Share information with third parties via:				
(i)		Trade associations, conferences	No	1.0	3.5	pa
(ii)		Stakeholder communications strategy	No	3.0	3.0	pa
(iii)		Press reporting	No	0.5	3.0	pi
(iv)		Newsletters	No	0.5	0.0	pi
O3	Recommendations	Inform and update users and authorities through:				
(i)		Updated environmental code of practice	No; A less certain	7.0	0.0	pa
(ii)		Inputs to policy making	No; A less certain	2.0	0.0	pa
O4	Mitigations	Set up management procedures, manuals, and systems to respond to issues of user compliance by:				
(i)		Registering/recording complaints	No	1.0	3.0	pa
(ii)		Consumer satisfaction surveys	No	0.5	0.0	pa
O5	Sustainability	Promote/monitor sustainable operations	No	0.5	1.0	pi
O6	Awareness	Establish, promote best practice:				
(i)		By educating stakeholders	No	1.0	0.0	pa
(ii)		By establishing awareness and training materials	No	1.5	5.0	pa

Table 7. Output processes and durations
CSR, corporate social responsibility; pa, [days] per annum; pi, [days] per incident.

monitoring programmes (O1i) to identify whether port users perform operations to standard. To facilitate continuous updating (ESPO, 2003) it is necessary to define environmental performance indicators. Next, relevant issues and communications with environmental stakeholders are documented (action O1ii). Electronic document sharing assists staff to access information, raises awareness of legislation and obligations, and ensures compliance. CSR reporting requires a comprehensive baseline database comprising reports, documents and operator records (Action O1iii). Directive 2003/04EC requires port administrations to process and update environmental information pertaining to their activities and projects. To comply and raise awareness of best practice and the professional profile of FHC, actions O2i and O2ii provide information sharing online before activities are assessed. To broadcast the environmental credentials of the port authority (ESPO, 2003) requires media contact (O2iii). Newsletters and similar updates to stakeholders (O2iv) enhance local engagement with AONB partners and visitors who pick up leaflets. Actions vary little between anchoring and bunkering operations, although the partners and responsibilities differ.

Regular updates to environmental codes of practice (O3i) for public and commercial harbour users aim to ensure compliance with Water Framework and EU Habitat Directives. Updates and recommendations for anchoring operations are necessarily ongoing as research into any potential impacts on maerl beds proceeds. Regarding bunkering operations, action O3i encourages bunker operators to apply the International Safety Guide for Oil Tankers and Terminals (ICS, 2006), incorporate procedures into the ship's safety management system to ensure

DOI: 10.1002/bse

that risks have been assessed and mitigation controls established and make oil spill contingency arrangements. Networking with agencies such as DEFRA (O3ii) seeks to promote inputs to policy.

For all maritime operations, FHC must explain how its evidence base is collated and monitoring procedures are established (action O4). Systems record (O4i) and assess (O4ii) FHC performance and incorporate procedures to handle complaints, litigation, appeals against decisions and compensation issues, to enhance client retention and customer relations. Regular spot checks on all types of operations are conducted to ensure compliance with relevant codes and to promote the ethos and practice of sustainability (O5). In aspiring to share knowledge of legislation and best practice with schools and community groups, using leaflets for marina users and online instructions for ships requesting piloting services, FHC emphasises its own corporate environmental awareness (O6i). To reduce human error which may cause accidents, action O6ii aims to share knowledge of legislation, good practice and mitigation procedures and ensure that personnel are qualified to conduct safe operations and prepared to tackle spillages. Such training is time- and cost-efficient in enhancing individual skill competences (ESPO, 2003).

The duration of each operational activity (Table 7) is broadly similar for most outputs, but FOS rather than FHC is responsible for some bunkering actions (O1ii, O2iv, O3, O4ii, O6i). The greater complexity of bunkering operations requires proportionately more FHC hours than anchoring to register complaints (O4i) and manage external communication via conferences (O2i), the media (O2iii) and awareness training materials (O6ii).

Discussion: Impact on the Port Authority

Because port authorities implement the systems framework directly, their likelihood of owning the evaluation process and embedding environmental awareness into their organisation is increased. A long-standing FHC EMS testifies to good practice, but in seeking further improvements, applications of business process thinking identified the importance of stakeholder engagement and management, later incorporated into a broader corporate 'sustainability management system'. Practical implementation benefits stimulated further applications to define and implement a quality management system to incorporate information spanning all FHC activities.

Because FHC implemented environmental assessments internally, stakeholder engagement increased, generating new contacts and offers of information sharing (Table 8). Unexpectedly, volunteers from EIGs now

System component	Before	After
Environmental agenda	Ad hoc	Systematic
Response to policy issues	Reactive	Proactive
Evidence of environmental performance	Number of spills	Consumer satisfaction reporting
HM input	Attends all meetings	Policy officer releases HM
FHC policy engagement	Compliance	Initiates debate
Who conducts assessments	Consultants	FHC initiates research
FHC engagement in environmental issues	Compliance	New initiatives, e.g. Portonovo
Role of external engagement	As required by statute	Encourage visits
Extent of external engagement	Statutory	Attend, e.g. BPA
Professional links	Trade bodies	Environmental bodies
Nature of stakeholders	Mainly governmental	Community and EIGs
EIG attitude	Suspicious	Work with FHC
Actions of EIGs	Complain	Advise on legislation
Anchoring technologies	No data analysis	AIS analysis
Pollution modelling	Oil spill records	Data buoy; PISCES
Nature of EMS	Piecemeal	Structured
Medium for EMS	Paper based	Web-based library
Training for	Users	New groups engaged

Table 8. Impacts of applying the systems framework
HM, Harbour Master; FHC, Falmouth Harbour Commissioners; BPA, British Ports Association; EIG, environmental interest group; AIS, automatic identification system; EMS, environmental management system.

DOI: 10.1002/bse

contribute to monitoring systems and offer responses to development proposals and legislative changes. A marine projects officer, recruited following proactive funding searches which attracted a KTP, releases time spent by the Harbour Master in attending routine meetings, and has empowered FHC to contribute vigorously to policy debates and technical issues. FHC proactively engages external bodies including the BPA to benchmark its performance and share best practice. Systematic recording of upcoming meetings ensures planned representation spanning more stakeholders including local initiatives considering low carbon issues and the Marine and Coastal Access Bill. Stakeholder analysis prioritised improved engagement with existing environmental stakeholders, but an improved public profile has attracted new requests from universities and harbour authorities to engage and visit.

Evidence that FHC environmental policy is effective includes quarterly SAC management meetings which audit records of all pollution incidents. No actions to date of non-compliance, or prosecutions, provide further evidence of compliance. Performance beyond good practice is evidenced by positive media coverage and involvement in KTP, Portonovo and Falmouth Habitat projects.

Implementing the systems framework improved decision making, providing a structured approach to identify and evaluate potential impacts and target resources on investigating the most serious. Clearer priorities focussed effort, saving time and resources. When the framework identified incomplete habitat research necessitating studies of maerl bed distribution, a novel anchor investigation was prioritised, triggering anchor analysis, AIS ship anchorage plotting and a dive investigation. Similarly, when a requirement to review and formalise hydrographic procedures emerged a specialist internship was initiated. The local marine school was invited to coordinate student projects to investigate the potential impacts of other local maritime operations identified in a brainstorming session.

In pursuing an evidence-based approach, FHC has established new technologies to assist the collection and analysis of data locally. AIS data have generated the first systematic recording of anchoring operations locally. To assist in predicting and hence mitigating the likely impact of oil spills, FHC deploys PISCES modelling and forecasting software. A bespoke buoy has been purchased to record tidal flows for input to the model. Training of employees and harbour users and increasing community and stakeholder involvement which should further reduce the risk of mishaps, are outputs in the systems approach which increase awareness. Over time FHC will become increasingly aware of its mission, and better able to achieve it, as outputs of data collection, monitoring, recording and consumer feedback are improved continuously.

Conclusions

To date, port authorities have rarely integrated predominantly physical environmental evaluations with business strategy. Similarly, business strategists have largely overlooked the environmental dimensions of ports as sensitive maritime interfaces. A new dialogue is urgently required to initiate both agendas. Port authorities should undertake initial applications of the systems framework internally to promote and enhance management's environmental awareness and grow commitment to environmental management, learning to incorporate it with business strategy. This commitment predicates increased deployment of complementary methodologies and physically based environmental monitoring tools and auditing systems.

Port authorities need to deploy the business process framework to identify strategic, tactical and operational levels of environmental management processes. Rather than conducting predominantly physical evaluations, refocusing on strategic missions will highlight educational dimensions to raise awareness of operational conventions and commercial dimensions to reduce costs of hiring in expertise. Consortia of smaller ports applying the framework should work collectively with neighbouring authorities to cost-effectively acquire and disseminate specialist knowledge, contacts and management systems, benefit from co-representation and engage proactively with funding initiatives to promote environmental awareness. Many authorities will need to prioritise revisiting the strategic role of stakeholder engagement, tactical management of service processes of networking, consultation and familiarisation and operational processes for external communication. Increased stakeholder engagement is imperative to enhance the evaluation process as new social capital is built.

The fecundity of cross-disciplinary fertilisation to inform frameworks to assist comprehension of environmental management practices is proven (Lucas, 2010). Similarly the systems framework which emerged from innovative application of business process thinking to environmental management processes within a maritime context and informed by business strategy, promises potential inter-sector benefits. Normative categorisation of the processes of environmental management at strategic, tactical and operational levels would benefit many organisations, encouraging commitment from senior managers to build an integrated, systematic and focused strategy. Analysis of activity durations assists resource allocation and planning of environmental management. By identifying any duplicate activities and revealing scope for transferring routine actions from senior managers to specialist staff, significant cost savings are likely. As exploratory research, this work concentrated on understanding and documenting the business processes of environmental management in ports. However, as more ports apply the systems framework a growing body of operational experience will present opportunities to re-engineer business processes, perhaps through simplification and optimisation. A challenge for the business strategy community relates to how this knowledge might best be pooled, managed and disseminated inter-organisationally.

Many ports and arguably other logistical or distributional facilities operating at fixed locations will benefit from applying the systems framework to manage the potential environmental impact of bespoke operations. Although details of each strategic input are context dependant, linkages to service and output processes will be similar. The framework encourages interlinking of relevant environmental codes and regulation with business strategy which promotes compliance. Further, this explicit strategic focus will stimulate enhanced intra-organisational managerial environmental awareness. Arising from this, pro-active development prompted by the framework will promote more sustainable execution of routine operations and infrastructure development, and more viable commercial operations. A highly sensitive environment at Falmouth involving multiple physical inputs generated a complex case study; fewer data inputs should be required elsewhere.

This study offers broader maxims for public policy. Within the maritime sector Ecoports is dedicated to supporting environmental management in ports, and offers graded tools to assist. Take-up to date has embraced few smaller ports and accessible tools are required to promote and assist environmental management in smaller ports as engines of future growth able to respond rapidly to technological developments. The risks of catastrophic environmental damage occasioned by unsustainable maritime operations and development must be offset against port closure and commercial failure pursuant on enforced cessation of operations. Benefits accruing from safeguarding revenue from maritime operations which ensure commercial viability and conducting environmentally sustainable operations informed by environmental specialists and appropriate environmental management tools far outweigh the costs of closure or environmental catastrophe. The systems framework offers one such tool, but enlightened contextualisation of environmental management within the business strategy of port authorities may reveal others.

Acknowledgments

Plymouth Business School teamed up with FHC in a KTP (no. KTP007098). This partnership received financial support from the KTP programme. KTP aims to help businesses to improve their competitiveness and productivity through the better use of knowledge, technology and skills that reside within the UK knowledge base. KTP is funded by the Technology Strategy Board along with the other government funding organisations, which included the National Environment Research Council, the Economic and Social Research Council and FHC. None of these bodies was involved in decisions relating to research design, data collection, data analysis, interpretation or dissemination.

References

AtoBviaC. 2010. *Sulphur Emission Control Areas*. AtoBviaC plc, UK. Available at: http://www.atobviaconline.com/public/PageContent.aspx?PageID=1041 [20 December 2010].

Backhurst MK, Cole RG. 2000. Biological impacts of boating at Kawau Island north-eastern New Zealand. *Journal of Environmental Management* **60**: 239–251. DOI: 10.1006/jema.2000.0382

Baylis R, Connel L, Flynn A. 1998. Company size, environmental regulation and ecological modernisation: further analysis at the level of the firm. *Business Strategy and the Environment* **7**: 285–296. DOI: 10.1002/(SICI)1099-0836(199811)7:5<285::AID-BSE166>3.0.CO;2-U

Chertow M, Miyata Y. 2011. Assessing collective firm behavior: comparing industrial symbiosis with possible alternatives for individual companies in Oahu, *HI. Business Strategy and the Environment* **20**: 266–280. DOI: 10.1002/bse.694

Cornwall AONB. 2010. A Management Plan for the Cornwall Area of Outstanding Natural Beauty. Author: Truro, UK. Available at: http://www.cornwall- aonb.gov.uk/documents/ [15 September 2010].

Cornwall County Council. 2005. *Economic Impact Study of the Port of Falmouth*. Author: Truro, UK.

Curkovic S, Sroufe R. 2011. Using ISO 14001 to promote a sustainable supply chain strategy. *Business Strategy and the Environment* **20**: 71–93 DOI: 10.1002/bse.671

Dahlsrud A. 2008. How corporate social responsibility is defined: an analysis of 37 definitions. *Corporate Social Responsibility and Environmental Management* **15**: 1–13. DOI: 10.1002/csr.132

Darbra RM, Pittam N, Royston KA, Darbra JP, Journee H. 2009. Survey on environmental monitoring requirements of European ports. *Journal of Environmental Management* **90**: 1396–1403. DOI: 10.1016/j.jenvman.2008.08.010. PMid:18929441.

Darbra RM, Ronza A, Stojanovic TA, Wooldridge C, Casal J, 2005. A procedure for identifying significant environmental aspects in sea ports. *Marine Pollution Bulletin* **50**: 866–874. PMid:15946703.

Darbra RM, Ronza A, Casal J, Stojanovic TA, Wooldridge C. 2004. The Self Diagnosis Method: a new methodology to assess environmental management in sea ports. *Marine Pollution Bulletin* **48**: 420–428. DOI: 10.1016/j.marpolbul.2003.10.023

DfT (Department for Transport) 2009. *Maritime Statistics 2008*. DfT: London.

DfT (Department for Transport) 2006a. *Focus On Ports* 2006 ed. DfT: London.

DfT (Department for Transport) 2006b. *Maritime Statistics 2005*. DfT: London.

DfT (Department for Transport) 2002. *A project appraisal framework for ports*. DfT: London. Available at: http://www.dft.gov.uk/consultations/archive/2002/afp/ [15 May 2009].

DfT (Department for Transport) 2000. *Modern ports: A UK policy*. DfT: London. Available at: http://www.dft.gov.uk/pgr/shippingports/ports/modern/modernportsauk policy?page=1 [29 May 2009].

Dinwoodie J, Xu J. 2008. Case studies in logistics: a review and tentative taxonomy. *International Journal of Logistics Research and Applications* **11**, 393–408. DOI: 10.1080/13675560802389130

Dinwoodie J, Knowles H, Tuck S, Benhin J. 2009. Assessing the environmental impact of maritime operations in smaller ports: a systems approach. *Logistics Research Network Conference Proceedings, Cardiff, September*. Chartered Institute of Logistics and Transport: Corby, U.K 536–543.

Ditlev-Simonsen CD, Midttun A. 2011. What motivates managers to pursue corporate responsibility? A survey among key stakeholders. *Corporate Social Responsibility and Environmental Management* **18**: 25–38. DOI: 10.1002/csr.237

EcoPorts. 2010. *Tool 4: Port Environmental Review System (PERS)*. EcoPorts: Brussels. Available at: http://www.ecoports.com/page.ocl?pageid=30 [15 September 2010].

EcoPorts. 2006. *The Top-10 Port Environmental issues*. EcoPorts: Brussels. Available at: http://www.ecoports.com/page.ocl?pageid=127 [19 June 2009].

Edoho FM. 2008. Oil Transnational Corporations: Corporate Social Responsibility and Environmental Sustainability. *Corporate Social Responsibility and Environmental Management* **15**, 210–222. DOI: 10:1002/csr.143

ESPO (European Sea Ports Organisation), 2003. *Environmental Code of Practice*. ESPO: Brussels. Available at: http://www.espo.be/downloads/archive/85817e87-5a24-4c43-b570-146cb7f36b68.pdf [4 August 2009].

Falmouth Port. 2009. *Falmouth Harbour Commissioners Environmental Policy*. FHC: Falmouth, UK . Available at: http://www.falmouthport.co.uk/pdf/FHC-environmental-policy.pdf [15 May 2009].

Falmouth Port. 2007. *Falmouth Habour Commissioners' Strategy*. FHC: Falmouth, UK. Available at: http://www.falmouthport.co.uk/pdf/strategy2007.pdf [1 May 2009].

Falmouth Port. 2003. *The Falmouth and Truro Ports Handbook*. FHC: Falmouth, UK. Available at: http://www.falmouthport.co.uk/pdf/ports_handbook.pdf [1 May 2009].

FOS. 2009. *Falmouth Oil Services Limited*. FOS: Falmouth, UK. Available at: http://www.fosoil.com/ [9 October 2009].

Gilman S. 2003. Sustainability and national policy in UK port development. *Maritime Policy & Management* **30**: 275–291. DOI: 10.1080/0308883032000145591

Hutchinson A, Chaston I. 1994. Environmental management in Devon and Cornwall's small and medium sized enterprise sector. *Business Strategy and the Environment* **3**, 15–22. DOI: 10.1002/bse.3280030102

ICS (International Chamber of Shipping). 2006. ISGOTT International Safety Guide for Oil Tankers and Terminals International. *Chamber of Shipping, Oil Companies International Marine Forum, International Association of Ports and Harbors*, 5th edn. ICS and Bermuda: Oil Companies International Marine Forum: London.

Idemudia U, Ite UE. 2006. Corporate–Community Relations in Nigeria's Oil Industry: Challenges and Imperatives. *Corporate Social Responsibility and Environmental Management* **13**, 194–206. DOI: 10.1002/csr.101

IEMA. 2010. Introducing EMAS. Lincoln, U.K Institute of Environmental Management and Assessment. Available at: http://www.iema.net/ems/emas [3 September 2010].

IMO (International Maritime Organisation). 2011. *IMO*. IMO: London. Available at: http://www.imo.org [23 March 2011].

Ketola T. 2010. Five Leaps to corporate sustainability through a corporate responsibility portfolio matrix. *Corporate Social Responsibility and Environmental Management* **17**: 320–336. DOI: 10.1002/csr

Ketola T. 2007. Ten years later: where is our common future now? *Business Strategy and the Environment* **16**, 3: 171–189. DOI: 10.1002/bse.477

Lagoudis IN, Lalwani CS, Naim MM. 2004. A generic systems model for ocean bulk shipping companies in the bulk sector. *Transportation Journal*, **43**(Winter), 56–76.

Lucas MT. 2010. Understanding environmental management practices: integrating views from strategic management and ecological economics. *Business Strategy and the Environment* **19**: 543–556. DOI: 10.1002/bse.662

Leopold LB, Clarke FE, Hanshaw BB, Balsley JR. 1971. A procedure for evaluating environmental impact. US Geological Survey Circular, 645. Government Printing Office, Washington,DC.

Loorbach D, van Bakel JC, Whiteman G, Rotmans J. (2010). Business Strategies for Transitions Towards Sustainable Systems. *Business Strategy and the Environment* **19**: 133–146. DOI: 10.1002/bse.645

Lund-Thomsen P, Nadvi K. 2010. Global value chains, local collective action and corporate social responsibility: a review of empirical evidence. *Business Strategy and the Environment* **19**: 1–13. DOI: 10.1002/bse.670

MCA (Maritime and Coastguard Agency). 2008. *Guidance on the Merchant Shipping (Ship-to-Ship Transfer) Regulations*. MCA: London. Available at: http://www.mcga.gov.uk/c4mca/080511_mgn_for_cons.pdf [4 August 2009].

Miller VV, Quinn J. 1998. The harvest strategy: how to implement a disaster for the environment and the stockholders. *Business Strategy and the Environment* **7**: 71–89. DOI: 10.1002/(SICI)1099-0836(199805)7:2<71::AID-BSE139>3.0.CO;2-S?????

Oxford Economics. 2009. *The Economic Contribution of Ports to the UK Economy*. Abbey House: Oxford.

Paipai E. 1999. *Guidelines for Port Environmental Management. Report SR 554*. HR Wallingford, Department of the Environment, Transport and the Regions: London.

Parnaby J. 1979. Concept of Manufacturing System. *International Journal of Production Research* **17**: 123–135. DOI: 10.1080/00207547908919600

Peris-Mora E, Diez Orejas JM, Subirats A, Ibanez S, Alvarez P. 2005. Development of a system of indicators for sustainable port management. *Marine Pollution Bulletin* **50**: 1649–1660. DOI: 10.1016/j.marpolbul.2005.06.048. PMid:16095626.

Pettit S. 2008. United Kingdom ports policy: changing government attitudes. *Marine Policy* **32**: 719–727. DOI: 10.1016/j.marpol.2007.12.002

Ray S. 2008. A case study of Shell at Sakhalin: having a whale of a time? *Corporate Social Responsibility and Environmental Management* **15**: 173–185. DOI: 10.1002/csr.170

Revell A, Blackburn R. 2007. The business case for sustainability? an examination of small firms in the UK's construction and restaurant sectors. *Business Strategy and the Environment*. **16**: 404–420. DOI: 10.1002/bse.499

Revell A, Stokes D, and Chen H. 2010. Small businesses and the environment: turning over a new leaf? *Business Strategy and the Environment*. **19**: 273–288 DOI: 10.1002/bse.628

Risk Support. 2001. *Linking Risk Assessment of Marine Operations to Safety Management in Ports*. Risk Support Limited: London. Available at: http://www.risk-support.co.uk/vmtMTS2001.pdf [15 June 2009].

Royal Haskoning. 2009. Green Ports. Available at: http://www.royalhaskoning.co.uk [5 February 2010].

Sarkis J. Helms MM, Hervani AA. 2010. Reverse logistics and social sustainability. *Corporate Social Responsibility and Environmental Management* **17**: 337–354. DOI: 10.1002/csr.220

Shah KU. 2011. Organizational legitimacy and the strategic bridging ability of green alliances. *Business Strategy and the Environment*. DOI: 10.1002/bse.706

Sroufe R. 2003. Effects of environmental management systems on environmental management practices and operations. *Production and Operations Management* **12**: 416–431. DOI: 10.1111/j.1937-5956.2003.tb00212.x

Tilley F. 1999. The gap between the environmental attitudes and the environmental behaviour of small firms. *Business Strategy and the Environment* **8**, 238–248. DOI:10.1002/(SICI)1099-0836(199907/08)8:4<238::AID-BSE197>3.0.CO;2-M

UK P&I Club. 2008a. *Sulphur content of gas oil – UK*. UK P&I Club: London. Available at: http://www.ukpandi.com/ukpandi/infopool.nsf/html/LPBulletin562 [20 July 2009].

UK P&I Club. 2008b. *Preventing pollution during bunkering operations*. UK P&I Club: London. Available at: http://www.ukpandi.com/ukpandi/InfoPool.nsf/HTML /LPNewsHead20081107 [5 July 2009].

UNESCAP (United Nations Economic and Social Commission for Asia and the Pacific). 2009. *Environmental impacts of port development*. United Nations: Bangkok. Available at: http://www.unescap.org/ttdw/Publications/TFS_pubs/ Pub_1234/pub_1234_ch2.pdf [5 June 2009].

Vernon J, Essex S, Pinder D, Curry K. 2003. The 'greening' of tourism micro-businesses: outcomes of focus group investigations in South East Cornwall. *Business Strategy and the Environment* **12**, 49–69. DOI: 10.1002/bse.348

Wang, C, Corbett JJ. 2007. The costs and benefits of reducing SO2 emissions from ships in the US West Coastal waters. *Transportation Research Part* **D12**: 577–588. DOI: 10.1016/j.trd.2007.08.003

Wilson C, Williams ID, Kemp S. 2010. Compliance with producer responsibility legislation: experiences from UK small and medium-sized enterprises. *Business Strategy and the Environment*. DOI: 10.1002/bse.698

World Port Source. 2010. *Port of Falmouth*. World Port Source: San Jose. Available at: http://www.worldportsource.com/ports/map.2866.1529.php [1 September 2010].