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Sustainable Financing for Ship-based Pollution Prevention and Management in the Malacca Straits

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MISSION STATEMENT

The primary objective of the Global Environment Facility/United Nations Development Programme/International Maritime Organization Regional Programme for the Prevention and Management of Marine Pollution in the East Asian Seas is to support the efforts of the eleven (11) participating governments in the East Asian region to prevent and manage marine pollution at the national and subregional levels on a long-term and self-reliant basis. The 11 participating countries are: Brunei Darussalam, Cambodia, Democratic People's Republic of Korea, Indonesia, Malaysia, People's Republic of China, Republic of the Philippines, Republic of Korea, Singapore, Thailand and Vietnam. It is the Programme's vision that, through the concerted efforts of stakeholders to collectively address marine pollution arising from both land- and sea-based sources, adverse impacts of marine pollution can be prevented or minimized without compromising desired economic development.

The Programme framework is built upon innovative and effective schemes for marine pollution management, technical assistance in strategic maritime sectors of the region, and the identification and promotion of capability-building and investment opportunities for public agencies and the private sector. Specific Programme strategies are:

- Develop and demonstrate workable models on marine pollution reduction/prevention and risk management;
- Assist countries in developing the necessary legislation and technical capability to implement international conventions related to marine pollution;
- Strengthen institutional capacity to manage marine and coastal areas;
- Develop a regional network of stations for marine pollution monitoring;
- Promote public awareness on and participation in the prevention and abatement of marine pollution;
- Facilitate standardization and intercalibration of sampling and analytical techniques and environment impact assessment procedures; and
- Promote sustainable financing mechanisms for activities requiring long-term commitments.

The implementation of these strategies and activities will result in appropriate and effective policy, management and technological interventions at local, national and regional levels, contributing to the ultimate goal of reducing marine pollution in both coastal and international waters, over the longer term.

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GEF/UNDP/IMO Regional Programme
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of Marine Pollution in the East Asian Seas

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The Malacca Straits Demonstration Project is coordinated by Mr. S. Adrian Ross, Senior Programme Officer, GEF/UNDP/IMO Regional Programme for the Prevention and Management of Marine Pollution in the East Asian Seas.

Executive Summary

This report examines sustainable financing mechanisms for the prevention and management of ship-based, transboundary pollution in the Straits of Malacca. Ship-based pollution includes not only oil spills but also garbage, plastics, oil, grease, sludge and other wastes. The Straits of Malacca are among the world's busiest waterways. Operating conditions for vessels are very difficult, and accidents are common. Further, many important natural resources of the Straits are vulnerable to pollution, such as mangroves, corals reefs, fisheries resources and beaches and resource-dependent activities, such as fishing, coastal tourism and recreation.

Many measures, such as navigational aids, vessel traffic systems (VTS) and contingency planning, can reduce and prevent pollution, but some of these are very expensive. To date, the three littoral States have funded most public measures to promote vessel safety in the Straits. To be sure, the littoral States benefit from vessels using their ports. However, some 20% of vessels transit the Straits without stopping at any port. Indonesia, Malaysia and Singapore incur substantial costs to support safety measures for the international community, and collectively they bear many environmental costs from marine pollution.

Benefit-cost analysis, when feasible, allows for a comparison of the gains and costs from proposed pollution prevention and management measures. If the comparison of benefits to costs is acceptable to policy-makers, sustainable financing becomes a critical issue. This is because: (1) inadequate funding obviously prevents effective implementation of programs, (2) the means of financing determine the distribution of costs and therefore influence acceptability, (3) the structure of fees and charges can influence operator behavior and perhaps the size of benefits and (4) financing options differ with respect to transactions costs, political feasibility, stability of revenues, or in other important respects, all of which influence their adequacy and effectiveness.

Ship-based pollution prevention and management measures examined in this report include: compulsory pilotage, salvage operations, vessel traffic information systems (VTIS), navigational aids/services, electronic charts (marine electronic highway), shore reception facilities, and contingency planning and oil spill response.

Sustainable financing mechanisms considered in this report emphasize (1) user fees and related cooperative mechanisms, when available and appropriate under UNCLOS and (2) liability for natural resource damages. Financing mechanisms focus on cost recovery, rather than on pricing strategies that might be used to capture monopoly profits, for example.

Also considered are (3) potentially attractive investments in private/public partnerships. Sustainable financing mechanisms are considered from the perspective of the countries of the subregion on a Straits-wide basis, user States, and international conventions, specifically the United Nations Conference on the Law of the Sea (UNCLOS).

User fees and, more generally, incentive-based approaches, have considerable appeal since they are based on the 'user pays' and the 'polluter pays' principles and reflect commonly-shared notions of fairness. They also can work to harness the power of the market to sustain pollution prevention and control measures, in effect using private incentives to serve the broader public interest. To be effective, however, markets must work, or appropriate mechanisms and institutional arrangements must exist to allow markets to function. Yet, major problems arise in devising mechanisms to prevent and control pollution in the Straits of Malacca because of market failure and institutional failure. Market failure occurs since (1) many navigational aids and safety measures are public goods giving rise to the well-known 'free rider' problem and (2) other safety measures, such as VTS and use of pilots, create important external benefits not captured in the market. Institutional issues largely stem from the fact that the Straits of Malacca is an international strait under the UNCLOS. UNCLOS prescribes littoral States from interfering with passage of vessels in international straits. This limits feasible actions of the littoral States, since they cannot levy or enforce a fee (toll charge) on vessels transiting the Straits, unless they call at a port. Other institutional challenges concern devising practical means to develop and implement sustainable financing for feasible collective actions among the three littoral States.

Financing mechanisms are generally evaluated using several criteria and factors. These include: (1) entities involved in the partnership; (2) administrative efficiency; (3) effectiveness as a region-wide instrument; (4) revenue generating potential; (5) potential for providing appropriate incentives; (6) fairness among users and beneficiaries of the Straits; (6) political acceptability among the three littoral States and (7) international implications.

Several preliminary conclusions are reached. Very briefly:

First, given the many navigational aid services that the littoral States of the Straits of Malacca provide to the international community, international contributions or payments to support the incremental costs of Straits-wide prevention and response measures have appeal on grounds of fairness, and indeed are encouraged under UNCLOS. However, with the exception of Japan and actions by the International Maritime Organization, few contributions apparently have been made.

In the absence of additional international contributions and payments, cooperative approaches among the littoral States for funding the incremental costs of navigational aids that support Straits-wide safety might be expanded. Cooperative approaches involving an assessment of fees on covered vessels at the first port of call are used elsewhere in the world.

Such cooperative approaches, using a uniform fee, may provide a useful model for the Straits of Malacca. The cost of administration is an issue, but this does not appear to have been a problem elsewhere. A very small fee on oil imported by, or containers delivered at, the Straits ports could raise substantial revenues.

Vessel traffic systems and pilotage are used extensively in the Straits and elsewhere. Neither measure is a cure all, but both can provide private benefits to vessel operators by improving vessel traffic movement. These measures also can create substantial external benefits for other vessels and the littoral States by reducing congestion, the number of accidents and their associated costs. However, vessels using the Straits of Malacca have no incentive to consider these external benefits, and vessels that do not call at any Straits port cannot be required to use either VTS or pilots while passing through the Straits. Greater use of these measures for high-risk vessels or in higher risk areas of the Straits of Malacca might be encouraged if the littoral States adopted a common policy stating that, in the event of an accident leading to any pollution damages to littoral states, vessels that had failed to use available VTS or pilot services would be subject to penalties.

Shore reception facilities for bilge and oily waste waters, hazardous materials and plastics and garbage reduce discharge of wastes from shipping and by that, improves environmental quality, a public good from which all can benefit. Shore reception facilities can be a private or public sector activity, or a partnership between the two. To recover costs, however, the scale of activity and the fees assessed must be adequate to ensure that revenues exceed costs. Special handling and inspections may be required for agricultural wastes or hazardous materials to avoid transferring pollution problems to landfill sites and surrounding areas.

A major issue concerns ensuring vessels to use port reception facilities. Compliance will be greater with low fees and timely transfer of wastes (or fees can be a "hidden" cost in general port fees). Commercial or public operations will have to meet the criteria of low fees and quick turnaround, otherwise vessels will have an incentive to illegally dispose of wastes in the Straits of Malacca. To enhance use of waste reception activities, port officials could require proof of proper discharge and inspect vessel for adequate waste storage capability. Penalties could be levied for inadequate facilities or records. Also, vessels caught illegally disposing of wastes could be assessed heavy penalties, but detection is extremely difficult.

Private participation may be enhanced by combining waste streams from different sources to ensure an adequate scale of operations. This might also improve the economics for recycling certain wastes. Public bidding by qualified contractors and oversight of contractors' performance and fees are other important elements of a successful private-public partnership.

A marine electronic highway (MEH) would allow vessels using the Straits of Malacca to employ sophisticated electronic charts and real-time hydrographic data. Substantial benefits would accrue, if an MEH enhances vessel safety, allows vessels using the Straits to carry greater loads and requires vessels avoiding the Straits to use the Straits. Proponents of the MEH suggest that the Global Environment Facility might be one way to fund the incremental costs of an MEH, although long-term funding and the role of the private sector are a key issue. One proposal is that littoral States participating in data gathering and sharing would be compensated for international cooperation by receiving royalty revenues from vessel operators for data usage.

Liability for pollution-related damages (natural resource damage assessment), a process for making polluters pay for response, cleanup costs and other costs of spills, is another financing mechanism. An effective NRDA system (1) provides a sustainable basis for financing restoration of natural resources injured by oil spills or other pollution and (2) provides incentives for operators to avoid pollution. These issues are addressed at length in a separate report (MPP-EAS, 1999b).

Introduction

Background and Issues

The natural assets of the Straits of Malacca provide services of enormous value to the three littoral States of Indonesia, Malaysia and Singapore and to the many regions of the world that directly or indirectly use the Straits (Chua et al., 1997). Collectively, the value of the sea lanes, fishery resources, recreation and tourism facilities, and highly productive ecosystems is in billions of dollars (e.g., Morisugi et al., 1992; Chua et al., 1997; MPP-EAS, 1999c), making the Straits among one of the most valuable international straits in the world.

Pollution from land- and sea-based sources, however, threatens the sustainable use of the natural assets of the Straits (Calow and Forbes, 1997; Hamzah, 1997). One important set of concerns is pollution from shipping. These concerns stem from the very high volume of traffic in the Straits, dangerous operating conditions and the economic significance of the sensitive resources at risk from pollution.

The Straits of Malacca is the most direct route for shipping oil from the Middle East to destinations in China, Japan, Taiwan, and Korea[1]. For example, more than 80% of the oil received by Japan comes through the Straits (Chua et al., 1997). Beyond oil shipments to Asia, many nations benefit from the transport of goods through the Straits on container ships, cargo vessels, bulk carriers and other vessels. In total, over 80,000 vessels transit the Straits annually, including over 32,000 oil tankers[2] (Chua et al., 1997; Naidu, 1997). Additionally, many fishing boats, passenger ferries and other craft operate in the Straits or engage in cross-straits transportation among the littoral States.

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[1] *A minimum keel clearance requirement of 3.5 meters prevents fully laden eastbound tankers over 200,000 deadweight tons from using the Straits of Malacca. Of eastbound (i.e., loaded) tankers, 72% use the Malacca-Singapore Straits, 21% the deeper Lombok Straits. In terms of oil volume, roughly equal amounts pass through Malacca-Singapore Straits (52%) and the Lombok Straits (48%) (Robinson, 1997; see also Chua et al., 1997).*

[2] *An accurate count of traffic in the Straits of Malacca is difficult and depends upon how one defines 'vessels' and whether one includes (1) both east and west bound traffic, (2) cross- and intra-straits traffic and (3) vessels that stop at Singapore but do not approach Singapore eastbound through the Straits of Malacca. Estimates as high as 99,888 in 1993 have been made (Chua et al., 1997; Naidu, 1997).*

The combination of narrow channels, shifting bottoms, fogs, shipwrecks, heavy traffic by many large vessels, extensive activity by fishing boats, ferries and other cross- and intra-country straits traffic make the Straits particularly difficult to navigate safely. This raises the risk of accidents, including strandings, groundings and collisions, and subsequent marine pollution. Evidence of the high risk of vessel operations in the Straits is reflected in the 476 vessel accidents—over 5 per year—that have occurred from 1978 to 1994. Of these, 98 were tanker accidents (Chua et al., 1997; Hamzah, 1997). Recent major accidents, including the *Evoikos* and *Orapin Global* further underscore the risks to shipping in the Straits.

One estimate is that 20% of all marine pollution in the Straits is from shipping. While the threat of major spills is a very important concern, pollution from ships, such as garbage, plastics, oil, grease, sludge and other wastes, are also issues confronting the Straits (Hamzah, 1997). Many important natural resources, such as mangroves, corals, fish and beaches, and resource-dependent services and activities, such as fishing and coastal tourism and recreation, are susceptible to pollution from ships (Calow and Forbes, 1997; Chua et al., 1997). A significant concern is that a major spill like the *Exxon Valdez* could wreak havoc in the narrow Straits, causing large-scale injuries to natural resources and major economic losses to important activities, including shipping.

Dangerous vessel operating conditions in the Straits and the potential impacts of pollution from shipping on valuable resource services are important concerns. Unless actions are taken to prevent and control pollution from shipping, risks are expected to increase due to an anticipated major expansion of vessel traffic supporting economic growth in the littoral States and in East Asia. China alone may double its oil imports by 2005, with much of this oil passing through the Malacca Straits (Chua et al., 1997)[3].

Many ongoing and planned services address pollution threats to the Straits from shipping (see Box 1). These include measures to:

1. prevent accidents, such as maintaining existing, and establishing new, navigational and other safety aids, dredging, removal of wrecks and expanding the use of new technologies and management practices;

2. reduce discharges of wastes by encouraging expanding use of waste reception facilities in ports, for example;

3. respond to and control the consequences of accidents, using salvage and regional spill response training, and contingency measures; and

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[3] *Malaysia's proposed US$2.7 billion land bridge may ameliorate traffic congestion and pollution risks in the Straits of Malacca. However, the timing and full implications of this potentially important development are unclear and are not considered in this report.*

Box 1. Existing Services for Pollution Prevention, Control and Management from Shipping.

1. Pollution from Shipping
   - Structural Measures
   - Lighthouses
   - Radar, buoys, racons
   - Dredging
   - Removal of wrecks

2. Information Systems/Data Provision/ Mapping
   - Vessel Traffic Information Services (VTIS)
   - Integrated electronic charts (ENCs)
   - Winds, tides and currents

3. Safety Design Measures
   - Hull requirements

4. Training
   - Contingency planning and response
   - Crew training; manning requirements

5. Safety Operations
   - Emergency search and rescue
   - Pilots and tugs
   - Salvage
   - Enforcement/compliance
   - Airborne surveillance and radar
   - Port vessel safety inspections

6. Pollution Prevention
   - Waste reception activities and facilities
   - Spill response & control

7. Regulations
   - Traffic restrictions (e.g hull clearance ban on dangerous cargoes)
   - Traffic separation schemes

4. compensate those incurring costs or suffering losses due to spills or other pollution incidents.

Many of these actions, however, require major investments and are costly to operate and maintain. Countries can weigh the relative benefits and costs of measures to promote efficient and environmentally safe vessel and port operations within their territorial seas. They are also free, within the market constraints of port competition to levy charges and fees, such as lighthouse, pilot and other port fees. However, many marine pollution management challenges arise when a waterway has the status of an international strait and therefore is subject to international conventions. Management of marine pollution is further complicated when potential management actions involve multiple littoral States, as the Malacca Straits. One set of challenges is institutional; the other is due to the nature of the services provided.

Institutional issues largely stem from the fact that the Straits is an international strait under the United Nations Conference on the Law of the Sea (UNCLOS). UNCLOS (Article 38) prevents littoral States from interfering with transit passage of vessels in international straits[4]. This limits feasible actions of the littoral States, since they cannot levy or enforce

[4] *It is recognized that under UNCLOS (Article 233), littoral States can enforce actions to protect their environment but States cannot deny or impair passage. The minimum under keel clearance of 3.5 meters is one such measure in the Straits of Malacca.*

a fee (toll charge) on vessels transiting the Straits[5]. Another institutional challenge concerns devising practical means to develop and implement sustainable financing for feasible collective actions among the three littoral States.

A second set of problems stems from the inherent nature of many of the services provided to enhance safe navigation, which limits use of market-based approaches in Straits cases—or requires consideration of innovative approaches. For example, navigational aids, such as buoys and lighthouses, and other measures, such as channel dredging and removal of wrecks, are what are called 'public goods' (Marlow, 1997; MPP-EAS, 1999a). Once provided, vessels cannot be excluded from the benefit that such safety measures provide; hence, it is impossible to link a charge with use—the service is available whether you pay or not[6]. The public good nature of many navigational aids and other safety measures creates the classic 'free rider' problem and is likely a major reason why Japan apparently is the only nation outside the Straits making significant donations to enhance the safety of vessel operations in the Straits. This, despite the provisions of UNCLOS (Article 43), specifically encouraging users to cooperate with littoral States in establishing and maintaining navigational and safety aids in international straits[7].

Other issues limit the use of markets and incentive-based approaches to prevent and control pollution from shipping. These include: (1) the potentially important external benefits associated with certain services, for example pilotage and vessel traffic systems; and (2) legal-institutional problems that have limited the potential effectiveness of the market for salvage operators to protect property and the environment. These two issues are explained below in more detail.

As a result of these two factors—market failure and institutional failure—navigational safety by default has largely been the responsibility of the littoral States. The three littoral States have spent many tens of millions of dollars on navigational aids, hydrographic information and services to reduce or control pollution from shipping (Muhammad Razif Bin Ahmad, 1997). To be sure, some of these services directly benefit the littoral States, but a significant benefit accrues to other nations (e.g., Morisugi et al., 1992). For example, some 20% of the vessels using the Straits do not stop at any port along the Straits (Chua et al., 1997; Hamzah 1997). Further, most of the major shipping accidents in the Straits have involved transiting foreign vessels (Hamzah, 1997).

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[5] *An exception involves direct services by, for example, salvers who upon being retained can charge a fee, or claim salvage rights in the event of non-payment.*

[6] *Furthermore, it may not be desirable to levy a charge per unit of use, even if possible. This is because public goods, once provided, may yield benefits at zero incremental cost; hence their use should be encouraged, not discouraged with high fees. A lump sum charge, such as an annual fee, may not discourage use.*

[7] *Even with public goods, not all users will 'free ride'. The theory of collective action shows that a user may bear some costs provided that the resulting benefits to them are greater than their costs (Olsen, 1965). As noted some 80% of Japan's oil moves through the Straits and hence (beyond or in addition to altruism) it may well be in Japan's interest to provide for some level of support for navigational aids.*

Environmentally safe and efficient transportation in the Straits requires major investments. The GEF/UNDP/IMO Regional Programme for the Prevention and Management of Marine Pollution in the East Asian Seas examined the benefits and the costs of ongoing or planned pollution management actions. Benefit-cost analyses can provide valuable information about whether anticipated benefits exceed costs, where both are defined broadly to include private as well as environmental costs and benefits. However, benefit-cost analyses of public projects often do not consider how projects will be financed, nor do they usually consider the implications of different financing and institutional alternatives for implementation[8]. Yet, to be successfully implemented and maintained, attention must be given to financing, to important institutional measures and to the distribution of benefits and costs in general. Financing in particular is important for some obvious and perhaps less apparent reasons:

1. Inadequate funding limits the effective implementation of pollution prevention measures.

2. Mechanisms used to finance projects, e.g., user fees versus general revenues, or different formulae for cost-sharing, have important distributional effects, which often are a major factor influencing how—and even whether—a policy is adopted (Zeckhauser, 1985).

3. Financing options can affect users' incentives, by that, influencing behavior and the resulting size of benefits.

4. Financing options may differ with respect to: ease of administration (transactions costs), political feasibility, stability of revenues or in other important respects, all of which influence whether and how measures are adopted, as well as their adequacy and effectiveness.

For all of these reasons, sustainable financing of pollution management actions is a significant issue in the Straits. At the same time, designing effective and feasible sustainable financing mechanisms for the Straits (and for international straits, in general) is difficult due to important and inherent institutional and market failure issues, as noted.

To sum, sustainable financing for the Straits has proven to be a difficult issue, and solutions remain elusive. Nevertheless, this seems an opportune time to revisit the financing issues, for several reasons. Two recent major ship accidents, the *Evoikos* and the *Orapin Global*, have again focused attention on navigation risks in the Straits. Technology advances and the spread of new initiatives in traffic safety management, such as vessel traffic

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[8] *See Musgrave (1969) for further discussion of benefit-cost analysis and financing when capital markets are not perfect, when social and private discount rates differ, and the distribution of benefits and costs are important.*

information systems (VTIS), and the possible widespread future use of sophisticated electronic charts in a marine electronic highway, have caused regional authorities to consider new measures for preventing and managing marine pollution in the Straits. Further, recent important research makes the case for new measures for sustainable financing and suggests some alternatives (e.g., Hamzah, 1997; Ross et al., 1997). Finally, the ongoing GEF/UNDP/IMO Regional Programme provides an important framework and forum for the littoral States to consider and advance, as appropriate, new financing mechanisms and cooperative actions to prevent and manage transboundary pollution from ships in the Straits.

Purpose and Scope

Purpose

This report identifies and assesses sustainable financing mechanisms to support measures to prevent and manage pollution in the Straits. The focus of this report is on shipping and on transboundary pollution issues. Sustainable financing mechanisms are considered from the perspective of the countries of the subregion on a Straits-wide basis, user states and international conventions, specifically the United Nations Conference on the Law of the Sea (UNCLOS).

Sustainable financing mechanisms considered in this report emphasize the following: (1) user fees and related, cooperative mechanisms, when available and appropriate under UNCLOS, (2) liability for pollution costs and damages and (3) potentially attractive investments in private sector-public sector partnerships (PPP), including potential investments under the build-operate-transfer (BOT) and related public-private programs. User fees and other financing mechanisms covered in this report focus on cost recovery, rather than on pricing strategies that might be used to capture monopoly profits, for example.

User fees and more generally, mechanisms employing incentive-based approaches, have considerable appeal. They are based on the 'user pays' and the 'polluter pays' principles and reflect commonly shared notions of fairness. They also can work to harness the power of the market to sustain pollution prevention and control measures, in an efficient manner, in effect using private incentives to serve the broader public interest (Schultz, 1975; MPP-EAS, 1999b).

To be effective, however, markets must work, or appropriate mechanisms and institutional arrangements must exist to allow markets to function. Major problems arise in devising mechanisms to prevent and control pollution because of market failure and institutional failure. As indicated earlier, many navigational aids and safety measures are public goods. Other safety measures create important external benefits not captured in the market. In other cases, institutional problems prevent effective reliance on user fees. As a consequence, developing methods to promote greater reliance on user fees for sustainable

financing of anti-pollution measures in the Straits is not a straightforward exercise. Indeed, Article 43 of UNCLOS specifically prohibits littoral States from levying fees on vessels that transit international straits, as opposed to fees on vessels calling at ports along the Straits. Given these two important factors, an alternative to user fees is suggested in some cases.

Scope and Criteria

Pollution Prevention and Management: Measures and Financing Mechanisms

Measures. This report focuses on the following *measures* or services to prevent or control sea-based transboundary pollution:

1) compulsory pilotage
2) salvage operation
3) vessel traffic information systems (VTIS)
4) navigational aids/services
5) electronic charts (marine electronic highway)
6) shore reception facilities
7) contingency planning and oil spill response

These measures are, or can be, taken by private parties (e.g., vessel and cargo salvage, shore reception facilities), governments (e.g., navigational aids), or a combination of the two (e.g., VTIS), to prevent or control spills or promote port efficiency. It is recognized that the above are not exhaustive measures and omit, for example, efforts for further cooperation and training among the Coast Guards of the three littoral States.

Mechanisms. Mechanisms are the means used to finance pollution prevention and management measures. Mechanisms currently used in the Straits rely primarily on national sources, but also include user fees, international donations and other support through international organizations, notably the International Maritime Organization (IMO). Liability used to compensate for response, control and cleanup of spills, as well as for payment for certain economic losses and for restoration actions, is another funding source for managing pollution by restoring the environment. Individual companies also spend considerable (but unknown) amounts on pollution prevention and response training, as well as on purchase of equipment to prevent and control spills and avoid other sources of marine pollution.

Financing mechanisms considered in this report are:

1) port dues
2) user fees

3) Revolving fund

4) Public-private partnerships

5) Privatization

6) Natural resource damage assessment

Briefly, the revolving fund is a source of money that the littoral States can draw upon—borrow—to finance response and cleanup activities in the event of a spill.

Natural resource damage assessment (NRDA) is a process to: (1) identify categories of costs and losses due to oil spills for which operators would be liable and (2) provide appropriate methods and standards to be used to quantify losses in monetary terms[9]. NRDA issues in the Straits are examined in detail in a report of the GEF/UNDP/IMO Regional Programme (MPP-EAS, 1999b) and are not addressed extensively in this document. Port dues are self-explanatory; public-private partnerships involve various cooperative approaches the private and public sectors might take to jointly address pollution from shipping.

Criteria. Straits-wide cooperative measures to prevent or control pollution may involve private-public partnerships (PPP). Each of these measures will be evaluated using the following criteria or factors:

1) entities involved in the partnership, their roles and responsibilities

2) administrative efficiency

3) effectiveness as a region-wide instrument

4) revenue generating potential

5) behavioral change potential

6) fairness and equity among users and beneficiaries of the Straits

7) political acceptability among the three littoral States

8) compatibility with available services

9) international implications

This document assumes that an overarching goal of sustainable financing is to contribute to the sustainable use of the Straits in order to maximize the value of its natural assets. Sustainable financing that supports sustainable and efficient use of Straits resources, therefore, is an important issue. Hence, attention must be given to market failure (public goods and externalities) and to institutional failure.

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[9] *Note, however, that NRDA can also be considered a pollution prevention measure, to the extent that it provides an incentive for vessel operators to exercise more care (Grigalunas and Opaluch, 1988; MPP-EAS, 1999a).*

Prevention and Management of Marine Pollution from Shipping in the Malacca Straits

Existing and Potential Cooperative Programs and Arrangements

Cooperative programs to prevent and control marine pollution from shipping in the Straits include arrangements to (1) provide funding to acquire and assemble resources for responding to spills and (2) plan, coordinate and carry out spill response and control actions.

Revolving Fund

The revolving fund is the principal funding facility available in the Straits of Malacca to assist early response to oil spills. Established in 1981 by an initial contribution of 400 million yen from the Malacca Straits Council for Japanese non-government associations, the revolving fund is available to the three littoral States who may draw upon it to meet response needs in the event of a spill. Any such amount must be repaid, with interest. To date, the fund has been used twice. Interest earned had been used on three occasions for oil spill combat exercises.

The fund is managed on a rotational basis with each of the littoral States serving as manager for a five-year term. Currently, Singapore is the coordinating State.

Revolving funds are common environmental financing mechanisms. For example, in the United States, under the Oil Pollution Act of 1990, a fee of US$0.05 per barrel of domestically produced and imported oil has been used to establish an Oil Pollution Fund of US$1 billion. The fund can be accessed readily by public officials following a spill to pay for response and removal costs, and will also compensate parties for damages they suffer, if the party responsible for the incident cannot be identified, or does not accept financial responsibility for the incident. If the fund is used, then the fund administrator subsequently brings legal action against the responsible party to recover costs and interest. It should be noted that the response and removal costs, when paid by the fund, are often higher than those that a firm would incur, if a firm immediately accepted responsibility and retained its own response company. This provides some incentives to polluters to act quickly to assume financial responsibility for an incident. Australia also has a fund based on a per barrel fee.

Most pollution insurance for ships operating throughout the world is supplied by Property and Indemnity (P&I) Club based in London and elsewhere in Western Europe. A revolving fund is useful in the Straits in cases where response actions following a spill are delayed due to problems with contacting an authorized agent, such as a P&I Club. A revolving fund also is useful when it takes time to resolve the national jurisdiction of spills, or where a polluter cannot be identified or refuses to accept financial responsibility immediately. A fund can help avoid delays in response, and hence can avoid potentially higher private (e.g., cargo and hull) and public (environmental) losses. For example, following the *Evoikos* incident, there was an eight-hour delay in response while salvers waited for approval to take action, which contributed to higher costs from this incident.

Important questions for the revolving fund include: Is the current fund for the Straits adequate? If it is inadequate, then what is the appropriate level for the fund? How might such an amount be raised? For what purposes could it be used? If it was an expanded fund, how might it be administered?

Deciding on what is an adequate size fund is difficult. A fund that is too large imposes unnecessary financial costs while an insufficient fund will not serve the purposes for which it was established.

The adequacy question in large part depends upon (1) the uses to be made of the fund and (2) the level of protection sought. For example, a fund could be for spill response and cleanup only, or it could also allow for extensive training and perhaps limited other activities (certain assessment, research and equipment purchases). A fund could be used to address training and response for spills of limited or average size, or it might focus on planning and training for a worst credible case. There is some concern about preparedness for a level 3 spill in the Straits, and the size of a larger fund might be based on such a large-scale endeavor with the idea that smaller spills can more easily be accommodated by individual states and private companies.

A very important issue is whether an expanded fund would provide for compensation for those suffering losses, if the responsible party cannot be identified (so called "mystery spills") or does not accept responsibility for a spill. If the revolving fund would cover compensatory claims, which categories of losses would be covered? What would be the standard of proof required to document a loss? These issues are addressed in a report on NRDA for the Malacca Straits (MPP-EAS, 1999b) and are not considered further in this document.

Given answers to these questions, one could look at recent experience with spills and associated costs (and damages, if these are to be included in an expanded fund) to get an idea of the likely demands to be made upon the fund. One could calculate an average amount that ought to be in the fund, and allow for a precautionary margin of error, using

statistical information based on records of past spills (or on anticipated damages under possible new rules).

Reasons to increase the fund include inflation in the period since the fund was established and the importance of additional training, particularly joint training among the three littoral States to tackle level 3 spills (Teh Kong Leong, 1997). Allowance also might be made for possible increases in cleanup standards over time, as has occurred elsewhere. Hamzah (1997) suggests a fund of $25 million, although the basis for this number is unclear.

Sources for additional amounts for the fund might include: (1) additional international contributions or (2) fees on oil shipments. Additional international contributions would be fair and consistent with UNCLOS' call (Article 43) for users and littoral States to share in supporting navigational safety measures. However, no contributions have been made to the revolving fund since its inception in 1981, and many Asian countries are under severe economic pressures. Thus, additional funding from international regional sources is not likely in the near future.

A very small fee per barrel might be levied on oil shipments through the Straits, although this appears to be inconsistent with UNCLOS[10]. A small fee per barrel delivered at Straits ports also could be used. However, this does not address the international fairness issue—having vessels that transit the Straits without stopping assume some of the costs of safety measures of benefit to them.

Revolving funds for *non-oil* pollution are used elsewhere; some elements of such funds might have relevance in the Straits. For example, in the United States the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA or "Superfund") provides for a multi-billion dollar fund. The fund, collected by fees on production by chemical companies, is available for use in remediating sites contaminated by releases of hazardous substances—not oil spills—when responsible parties cannot be identified or are unable or unwilling to assume immediate responsibility for cleanup. Responsible parties are required by law to reimburse the fund. Under CERCLA, responsible parties also are liable for monetary damages and restoration of natural resources injured due to chemical pollution.

CERCLA has been applied in many cases involving marine sediments contaminated by polychlorinated biphenyls, mercury and other substances, for example (Grigalunas and Opaluch, 1988). Contaminated marine sediments appear to be an issue at several locations in the Straits (Calow and Forbes, 1997), and a revolving fund for hazardous chemicals

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[10] *Some 3.23 million barrels of oil per day (1,179 million/year) transit the Straits of Malacca (Chua et al., 1997). Thus a fee of as little as US$0.02 per barrel would raise US$23.6 million per year.*

might be a way to address pollution from hazardous substances in the Straits. NRDA for non-oil pollution also is addressed in a recent report of the GEF/UNDP/IMO Regional Programme (MPP-EAS, 1999b).

Cooperative Arrangements

Several cooperative arrangements exist in the Straits to prevent and manage pollution from shipping. Cooperative arrangements in international straits elsewhere in the world also might provide lessons for the Straits.

Straits of Malacca

Oil spill response cooperatives in the Staits. The East Asia Response Private Ltd. (EARL) was established in 1992 as a non-profit company by several major oil companies. Participation in EARL is open to any oil-related company in the Asia-Pacific region; each participant member pays a retainer fee to EARL, which responds to oil spill incidents involving member companies. The Singapore Oil Spill Response Center is also supported by member companies. Like other response organizations, they also will respond to calls for assistance by others on an as-available basis. In addition to EARL, large tanker companies, such as Ocean Tankers Ltd., which operates over 100 vessels, have their own designated person and response team.

The International Association of Independent Tanker Owners (Intertanko) is another private sector cooperative whose tankers operate in the Straits and worldwide. Intertanko, whose members operate 1,900 tankers, recently reaffirmed its commitment to the International Safety Management (ISM) Code. The ISM Code is incorporated into the IMO treaty regarding the safety of life at sea (SOLAS) and requires ship owners to establish pollution-prevention policies aboard their ships.

Intergovernmental cooperative mechanisms. The Petroleum Association of Japan (PAJ) is a non-profit, non-government trade association established in 1955. The PAJ Oil Spill Cooperative stockpiles and lends oil spill response equipment, and undertakes research and development on oil spill and response techniques. In the event of a spill, PAJ will lend stockpiled equipment at no cost. Currently two stockpiles of equipment are in the Straits (Chua et al., 1997).

Japan also has promoted a Cooperative Project for Oil Spill Response and Preparedness (OSRAP), with funding from the Japanese government. OSRAP is intended to foster cooperation between Japan and ASEAN countries, including development of an oil spill information system and regional oil spill contingency plan (Chua et al., 1997).

The Malacca Straits Council, a non-government organization of Japanese businesses, provided the initial 400 million yen funding for the revolving fund, outlined above. This can be viewed as a cooperative venture, in this case, among the three littoral States. The revolving fund is intended to facilitate oil spill cleanup in the event of a spill. Additionally, the Council funded the installation of 40 navigational aids at 30 locations from 1968 to 1988 in the Straits and donated them to Indonesia and Malaysia. The Council also has replaced and maintained some buoys in the Straits, and donated a buoy tender (Koike, 1997).

International organizations. The International Maritime Organization is the recognized international authority for maritime safety throughout the world. IMO provides many cooperative arrangements among the littoral States in the Straits for addressing vessel safety, navigational issues, crew training and measures to enhance clean seas. IMO also encourages public-private partnerships (e.g. Ross et al., 1997) to prevent and control marine pollution.

Other Geographic Areas

Cooperative arrangements among littoral States and between users and littoral States in other areas of the world provide elements of a framework that perhaps could be used for the Straits. Several are outlined below, primarily drawing upon case summaries in Hamzah (1997).

The United Kingdom and Ireland levy light dues to cover expenses for lighthouses, buoys, beacons, tenders, etc. It is estimated to involve an annual cost of 26.5 million British pounds per year. A centralized fund is maintained. Light dues are paid per vessel, based on its net tonnage, for arriving at or departing from ports in the UK or the Republic of Ireland. Special arrangements exist for small vessels and frequent callers (Marlow, 1997).

The Gulf Area of the Middle East, the Middle East Navigation Service (MENAS) also cooperatively collects fees to support navigational aids. Fees are assessed at the first port of call, and are based on net tonnage, and apply to vessels that are on a trading voyage in the Gulf. Exemptions include warships, vessels stopping only for bunkering and vessels taking refuge in the Gulf from storms (Marlow, 1997).

Note that in the above examples, dues are levied only at vessels calling at ports for purposes of trading. Liability in the event of an accident is always a concern, and it should also be noted that the collecting authority (at least for MENAS) specifically holds itself free from liability for losses or damages which may result from services rendered.

Other examples of cooperation to address navigation and environmental issues in several international straits by Scovazzi (1997); Smith and Roach (1997) and Van Dyke

(1997), also provide useful information. This international cooperation takes several forms. For example, in the Dover Straits, England and France have established a traffic separation scheme that apparently has been effective in preventing collisions. According to Van Dyke (1997), less success, however, apparently has been experienced in enforcing pollution-control regulations on vessels, which have limited incentives to comply. He stressed that in order to enhance effectiveness of environmental measures for ships, each of 14 participating Western European countries are required to inspect at least 25% of the foreign vessels that visit its ports.

To summarize, in general, littoral States are limited in what they can do to control pollution from ships in international straits, despite provisions in Article 233 of UNCLOS, although the limitations on actions are not totally clear (Van Dyke, 1997). Littoral States have somewhat more latitude to control pollution if their straits fall into the "long-standing" category, for example, the Turkish Straits, but this does not apply to the Malacca Straits. In any case, the right to unimpeded passage of foreign-flag vessels appears virtually sacrosanct, except in the case of belligerent countries during wartime.

Two positive lessons for the Straits can be gleaned from the case studies cited above:

1. *Cooperative Dues Collections*. Littoral States can cooperate in collecting fees for navigational aids, and then can share the revenues to defray costs among the participating countries. This is done in the UK-Ireland and the Middle East Gulf Area cases cited above.

2. *Vessel Inspections*. Littoral States can inspect vessels to ensure they meet safety standards, as is being done in Western Europe, for example. Presumably, fines and penalties are levied if vessels are found to violate pre-established standards; and vessels can be detained until safety standards are met. Port state control does allow restriction of non-complying vessels (structural, equipment, crew and records) in the Straits, when such vessels enter the territorial waters/ports of the three littoral States. In fact, Singapore is already applying such controls, but does not have the capacity to inspect all ships. A sampling of vessels for inspection may be adequate, however[11]. In this regard, one might focus scarce inspection resources on those ships that are not listed as being in compliance with the ISM Code, described above. The International Association of Classification Societies has just made available on Internet a list of vessels that have received certification of compliance with the ISM Code. Although the list is not complete, it will be updated monthly and is the most significant source available.

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[11] *Ships will comply with safety requirements when the expected value of compliance exceeds the expected value of the costs from being found in violation. Hence, given the size of the penalty for violations, the number of inspections by a littoral State must be high enough to create the incentive to comply, i.e., to raise the vessel's probability of detection sufficiently high for it to comply. Increasing the number of inspections, however, is costly and an efficient sampling strategy for monitoring becomes important.*

Existing and Potential Services

Existing and potential services[12] to prevent or manage pollution from shipping activities and operations are interpreted broadly. These are: (1) "structural" measures, (2) information systems, (3) safety operations, (4) safety design, (5) pollution prevention measures, (6) training, (7) regulations and (8) port safety inspections. These are presented in Box 1. These services are, or could be, provided privately, or by government at various levels: a port authority, national government or by a regional authority. IMO provides many services relating to vessel safety and crew training.

It is recognized that some measures or services to prevent pollution from ships—double hull requirements for vessels, for example—cannot be applied in the Straits. This is because its status as an international strait precludes littoral States from restricting vessel use based on vessel structural requirements. Hence, structural requirements for vessels are not discussed further in this report.

User Charges for Cost Recovery for Services

General

Similar to ports worldwide, all major ports in the Straits levy a variety of traditional fees, dues or charges on vessels, such as pilot charges, tug services and other port fees. Port services and charges for selected, important Straits ports are given in Table 1. Fee structures in Straits' ports appear to promote vessel efficiency by charging fees that reflect the higher marginal costs associated with accommodating larger vessels, and some ports offer lower fees for day-time periods[13].

Specific

Compulsory Pilotage

Pilotage services entail the use of local vessel pilots whose extensive knowledge and experience with local conditions and the local language allows them to guide vessels into and out of ports with enhanced safety. Pilotage services involve contracts between the pilots and vessels, hence financing is by the user; and in that respect pilot services are akin to private goods. Pilots, however, may also promote more efficient travel by reducing congestion. Pilots also likely lower the chance of accidents and their associated costs.

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[12] *The minimum under keel clearance requirement of 3.5 meters is one (of many) such regulations but is not a "service" as such.*

[13] *Strict liability is another mechanism for cost recovery. Following spills of oil, littoral States can recover cost of response, cleanup and at least some restoration costs.*

Table 1. Summary of Navigational Aids, Pollution Control Measures and Fees for Singapore and Indonesian and Malaysian Ports[a]

Service	Singapore (US$)	Belawan (US$)	Dumai (US$)	Blang Lancang (US$)	Port Dickson (US$)	Port Klang (US$)
Pilotage & Tugs						
Pilots/hour	C:100-300[b]	C:304	C	C:993-1042[d]	C:Tankers only	C:75-306[c]
						140-405
Tugs/hour	160-590[c]	2,022				230-450/1st[c]
						115-225/additional
VTS	Yes	No	No	No	No	Yes
Other Aids						
Lighthouses	Yes	Yes	Yes	Yes	Yes	Yes
Buoys	Yes	Yes		Yes	Yes	Yes
Beacon	Yes	Yes		Yes	Yes	Yes
Waste Reception						
Garbage	Yes - Reporting required		Yes (for domestic tankers)		?	Private
Oil	Private				Private	?
Bilge						

C = compulsory
[a]Source: Fairly Ports Guide
[b]Higher fee applies if vessel gives less than 4 hours advance notice
[c] Increases with size of vessel
[d]Different fee for LPG & LNG by size of vessel

Singapore has a mandatory pilotage system for certain hard-to-operate vessels (e.g., VLCCs, vessels under tow). Indonesia and Malaysia also have pilot services at major ports (see Table 1).

A central issue concerns whether the incremental benefits of requiring pilotage for vessels operating in the Straits exceeds the cost. Pilotage creates both private benefits that are received by the vessel operator and external benefits that go to parties other than the vessel operator. Private benefits include reduced operating costs from expedited travel and lower costs from fewer accidents. External benefits include lower congestion costs and fewer accidents and lower environment-related damages. The external costs imposed by vessels are not unlike the congestion costs automobile drivers impose on those behind them in heavy traffic, and the costs that airplanes place on other flights during peak use for airports.

If the private benefits exceed the costs of retaining the pilots, then pilotage makes good business sense and will be done as a matter of course by a vessel operator; compulsory pilotage would not be needed. However, many of the benefits from pilotage accrue to other parties, rather than to the vessel owner who employs a pilot. As noted, use of pilots reduces the chance of accidents and also enhances efficient vessel movement, thereby likely reducing congestion costs. For example, some 100-200 vessels transit the Straits each day. If a vessel causes an hour delay to each of 20 vessels behind it in a queue, and each vessel has hourly operating costs of $1,000, then the total external costs imposed by the first vessel on

subsequent vessels in this case is $20,000. Yet, the first vessel does not consider the costs it imposes on others. Also, accidents result in response and cleanup costs, commercial losses, and perhaps losses to the environment that may not be taken fully into account by the vessel.

Figure 1 illustrates the issues involved with compulsory pilotage. DD is the (hypothetical) demand for vessel trips through the Straits for a given period. DD is near vertical at low costs, because substitutes for the Malacca Straits (e.g., the Lombok Straits) are limited and very costly. The demand curve becomes flatter at very high costs—in the many tens of thousands of dollars per trip—approaching the extra cost to use the next-best alternative, the Lombok Straits.[14]

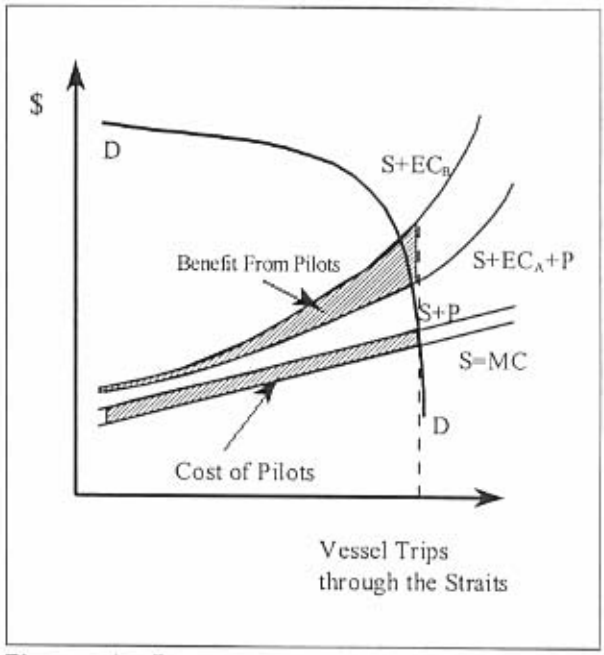

Figure 1. Demand and Supply Curves for Compulsory Pilotage.

The supply curve, S, is the private, marginal costs (MC) to vessel operators using the Straits. These increase with greater use. However, with greater use, external costs before compulsory pilotage, EC_B, become large reflecting congestion and environmental costs. In the figure, hypothetical external costs are depicted as quite large. Use of pilots add to private marginal costs and the figure is reflected by the additional costs for pilot services (S+P). Pilots are presumed to be effective in reducing congestion and environmental costs, so that the supply curve reflecting private costs, external costs and pilotage ($S+EC_A+P$) shifts down. In this case, compulsory pilotage is worthwhile and creates net benefits equal to the cross-hatched area in Figure 1.

Unfortunately little seems to be known about the magnitude of external costs in the Straits. Information is available about the location of some spills (Murad, 1985) and some of the costs of individual spills (Hamzah, 1997). However, no study seems to have been done on the cost of congestion in the Straits. Nevertheless, qualitative discussions of issues facing the Straits emphasize congestion as an important concern and one that will get worse with increased traffic, unless navigational measures are implemented. Data for the hourly costs of pilots are available for particular ports (see Table 1 for examples of Straits port-related hourly pilotage costs).

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[14] *Estimates in Chia (1997) suggest that the cost per trip would have to be US$ 80,000 for vessels 80-250 thousand DWT. These are his estimates of the extra costs vessels of the given size would incur to use the Lombok Straits rather than the Straits of Malacca.*

Using the reasoning given above, the more serious the potential for congestion, and the greater the risk of accidents, the stronger is the case for compulsory pilotage. Available qualitative information on growing congestion and risky operating conditions in the Straits, and quantitative data on the accident frequency in the Straits, suggest that a case can be made for compulsory pilotage for the Straits. The case for compulsory pilotage is strongest for areas that are (1) particularly difficult to navigate, (2) have large potential for damages in the event of a spill and (3) are subject to much congestion. However, unless a new institutional approach can be found, compulsory pilotage would appear to violate the UNCLOS prohibition on interference with passage of vessels.

One possibility is for the three littoral States to recommend strongly that operators of high-risk vessels (e.g., very large vessels; large vessels with special cargoes, such as heavy oils or chemicals) use pilotage services when transiting the Straits, or the more treacherous parts of the Straits (e.g., One Fathom Bank and the Straits of Singapore). Pilotage likely cannot be made compulsory, since this apparently violates UNCLOS. However, in the event of an accident, littoral States would usually have the opportunity to bring actions against the responsible party, as they do currently. At this point, littoral States could impose more severe penalties against vessels causing accidents resulting in environmental damage that did not use the recommended pilotage services[15]. The use of compulsory pilots, as suggested here, would require coordination and training among the three littoral States.

Further, pilotage rates might be set to guide usage toward preferred use times. Interestingly, individual ports in the Malacca Straits already use this type of time-differentiated pricing. For example, Port Klang charges a lower rate for daytime operations and charges vessels more for pilots if they provide inadequate advance notice of arrival time (Table 1; Watson, 1998)[16] This approach might also help reduce congestion.

The advantages of these options are (1) they seem relatively easy to implement, (2) they are based on the user pays principle, (3) they can be tailored to the riskiest areas, vessels, cargo types or times and (4) they are likely to be effective in that human error remains an important cause of accidents. Note also that pilotage fees are unlikely to cause vessels to avoid the Straits since the cost per trip would be so small compared to the very high cost (many tens of thousands of dollars) of an alternative route, such as the Lombok

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[15] *Levying penalties on vessels not using pilots may be complicated in some cases when multiple vessels are involved in an accident. For example, if one vessel did not engage a pilot, but a second vessel caused the accident, it would not be fair to penalize the first vessel. Yet, assigning fault or degrees of fault can be complicated.*

[16] *Although there are obvious differences across travel mediums, attempts to introduce market mechanism to control traffic flow and safety are common. For example, Singapore has introduced peak-use road pricing to reduce congestion, and airlines charge higher prices for peak-time arrivals and departures. Market pricing (and privatization) of a 15-mile stretch of highway in southern California allows users to avoid traffic jams on the adjacent public highway.*

Straits. Nevertheless, pilots are no panacea, and additional training and examinations may be necessary (Golob's Oil Pollution Bulletin, 1998).

Navigational Aids

Navigational aids is a general term that includes such measures as charts, buoys, radar, racons, lighthouses and provision of up-to-date hydrographic, tidal, current and wind information. Based on Muhammad Razif Bin Ahmad (1997), there are 256 navigational aids in the Straits: 10 lighthouses, 103 light beacons and 143 light buoys.

Navigational aids are very expensive to provide and maintain. For example, Malaysia intends to install a system of 18 buoys for an expanded traffic separation scheme, and must incur other large costs since buoys must be continuously maintained. Despite this major cost, the system of buoys may not be optimal because there may not be enough buoys to allow for line-of-sight navigating from buoy to buoy.

Existing financing. Currently navigational aids are supported by (1) port users, (2) the three littoral States and (3) donor countries—specifically, Japan. In the case of individual ports along the Straits, financial mechanisms such as light dues or lighthouse dues for funding navigational aids serving the port itself are in place (see Table 1). The only apparent issue is the perception that such dues may affect a port's relative competitiveness.

A major issue for those concerned with sustainable financing, of course, concerns navigational aids that assist vessels transiting the Straits but do not call at ports in the Straits. This is an important issue since of the 80,000 or so vessels that annually use the Straits, an estimated 20% do not call at any port (Chua et al., 1997). As noted, it is contrary to Article 43 of UNCLOS to levy any tariff on such vessels.

Potential new mechanisms[17]. Several options can be envisioned, each with its strengths and weaknesses:

1. **Cooperative Collection of Dues for Navigational Aids.** The littoral States could levy uniform dues to finance navigational aids used primarily to support transit through the Straits—i.e., *incremental* costs—as opposed to those aids that a nation would elect to provide for safety for its own territorial seas. Following the models for the UK-Ireland and Middle East Gulf Area, outlined above, dues would be collected for vessels engaged in trade in the Straits, with the amounts collected subsequently shared among the three littoral States based on their incremental costs. Exempt from dues would be warships and government vessels, vessels stopping for

[17] *See also the Peet (1997) who addresses several of the issues raised in the text.*

emergency services or to avoid severe weather or environmental conditions. Special arrangements would have to be made for frequent-use vessels, such as ferries and fishing boats.

To operationalize such a process, estimates must be made of the incremental investment, operating and maintenance costs to be financed. Fortunately, aggregate estimates of such costs have been made for Malaysia and apparently for Indonesia (Muhammad Razif Bin Ahmad, 1997). These cost estimates may have to be refined, and estimates are needed for incremental costs on the part of Singapore.

The advantages of this approach are obvious. It follows the user pays principle; and transactions costs (collection and distribution costs) are low. Further, a uniform levy across ports should allay concerns among ports about loss of relative competitiveness in trade.

Shortcomings are equally apparent. Only those vessels calling at a port in the Straits would pay; vessels that transit the Straits without stopping at a port (an estimated 20% of all vessels) would pay nothing. Overall, increased fees should not cause vessels to avoid the Straits since the benefit per trip from use of the Straits as compared to the next-best alternative route is so much larger than any conceivable, realistic fees (Chua, et al., 1997; Muhammad Razif Bin Ahmad, 1997).

2. **Funding through International Organizations.** This alternative would call upon international bodies, with IMO in collaboration with GEF presumably taking the lead, to promote making international funding available to coastal states. This approach is worth raising because it appeals as a potential long-run solution.

Rationale. Unimpeded transit of international straits is guaranteed under Article 38 of UNCLOS. Article 43 of UNCLOS urges cooperation between users and littoral States in supporting navigational aids. However, little has been forthcoming and prospects for major donations are not promising. This is due to the classic free rider problem associated with public goods and perhaps to some extent, the current financial difficulties of many Asian countries. The littoral States of the Straits are not the only states to face this problem; it is a worldwide issue.

One way to view Article 43 is that the world community recognizes the value of international straits and urges littoral States to perform an extraordinarily valuable service on behalf of all users. At the same time, Article 43 imposes a net cost on many of these states, in effect creating an unfunded mandate[18]. Funding from an

[18] *Smith and Roach (1997) report that the right to unimpeded access through international straits under UNCLOS was negotiated in exchange for a wider (12 mile) territorial sea. Such issues are outside the scope of this report.*

international agency would address the service provided to the international community and would be for the *incremental costs* littoral States incur due to their status as an international strait.[19]

Additionally, the incidence of an international cost-sharing approach, in effect, would have worldwide beneficiaries that bear costs in rough proportion to the benefits they receive. Few estimates have been made of the overall benefits of major international straits,[20] and only recently have systematic attempts been made to estimate the costs of navigational aids for the Straits (Muhammad Razif Bin Ahmad,1997). However, a reasonable hypothesis is that such a study would find that, in aggregate across all straits, the benefits are about in proportion to each country's share of the world economy. This is roughly the formula used to fund the United Nations, for example. Hence, an international cost-sharing approach would be fair in that it would share costs among beneficiaries. Further, accepting the view that funding of navigational aids has been inadequate, international funding would provide a more optimal level of support for preventing and managing pollution.

Implementation Issues. Among the important issues are: (1) marshaling the support for eventual approval of such a program; (2) devising a methodology for determining what is adequate funding for such a program; (3) prioritizing the need for additional support among international straits, and (4) guarding against rent seeking.

Issue 1 is political and outside the scope of this effort. Arguments on behalf of international funding for the Straits can be found in the various papers given in proceedings volumes edited by Hamzah (1997) and Ross et al. (1997), for example.

Devising a methodology for assessing an adequate funding level, Issue 2, would involve considerable work, including data gathering and analysis, and some trial and error. Generally speaking, however, one could carry out a survey among the littoral States in which the reasonable incremental costs of given navigational aids would be assessed. This might be done for the Malacca Straits and other, selected major straits initially, and indeed important strides have been made for the Straits (e.g., Muhammad Razif Bin Ahmad, 1997; Ono, 1997).

Issue 3 presents thorny problems because the availability of funds creates incentives for rent seeking in the form of overstating minimum costs and/or gold plating.

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[19] *Some navigational aids provide "joint products"—safety for vessels transiting straits and calling at ports along the straits—so it will be difficult or impossible to separate costs between the two groups in some cases. Assumptions and judgments necessarily will have to be employed.*

[20] *Estimates have been made for specific straits (Morisugi et al., 1992).*

Government agencies must deal with similar issues all the time. Benefit-cost studies might be used to guide the allocation of funds (Marlow, 1997; MPP-EAS, 1999a).

3. **User- or Benefit-based Cost-Sharing Schemes With Moral Suasion**. Estimates of users (or user benefits) would be made for the Straits. The results of such analyses would provide the basis for a direct appeal to those benefiting the most from the services of the Straits to donate funds in the spirit of UNCLOS (Article 43).

Rationale. This approach has appeal on the grounds of fairness. It would: (1) provide the littoral States with compensation for the incremental costs of navigational aids, and (2) redistribute costs to those who benefit, i.e., the user pays. A major point in its favor is the voluntary nature of this alternative, avoiding the herculean and highly problematic efforts needed to revise UNCLOS to achieve Option 2.

Issues. Principal issues include: (1) defining who are users, (2) estimating users' benefits, (3) deciding upon the level of adequate (incremental) funding and (4) designing mechanisms to distribute this funding. Issue (3) is a common issue for any approach.

Defining users of the Straits seems straightforward but has been a matter of some debate. Are users, shippers, the originating countries (e.g., oil producers), those who receive the goods, or some combination of these entities?

First, users are defined as the parties that benefit from the services of the sea lanes in the Straits. The shipping industry is assumed to be sufficiently competitive, so that any changes in transport costs (increases or decreases) will be fully reflected in the shipping rates in the long run[21]. Changes in shipping rates, in turn, will be passed on to the consumers and to the suppliers of goods shipped through the Straits. The exact sharing of cost increases and decreases between consumers and producers depends upon the nature of demand and supply relationships for categories of goods (oil, container products, cargos, etc.) passing through the Straits. A careful study of the market for goods and services passing through the Straits is much beyond the scope of this report. In general, however, in the long run, it is reasonable to expect that charges in transportation costs will be shared by both consumers and producers of goods shipped through the Straits.

A pragmatic implementation policy could focus on physical measures of traffic to estimate cost shares. This raises the obvious question of *what* measure of traffic would serve as an index: the number of vessels, the number of vessels by category,

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[21] *Long run is emphasized. In the short run, shippers bound by contracts may be forced to absorb cost increases. Some may gain if rates decrease due to a new navigational measure.*

by size, etc. On the other hand, a focus on traffic, rather than benefits avoids the need to quantify monetary values of benefits, a task which can be done but adds much complexity and additional challenges.

Estimating benefits to be used as a basis for cost-sharing would be a challenging but not impossible task. For example, Morisugi et al. (1992) estimated the aggregate economic value of the Malacca Straits for shipping. However, if benefits are to be used, the issue is not the total economic value of the Malacca Straits but the incremental value associated with provision of additional navigational aids. Hence what is needed are micro studies of particular navigational safety measures or, perhaps, combinations of measures and the resulting distribution of benefits.[22] Such studies face many difficulties, particularly in quantifying environmental effects, but are often done as part of regulatory impact analyses.

Perspective on Dues/User Fees

Although exact cost figures are hard to derive, one estimate is that Malaysia alone has committed the equivalent of many tens of millions of US dollars for investment and maintenance and operating costs for vessel safety in the Straits (Muhammad Razif Bin Ahmad, 1997). This includes the cost of navigational aids and their maintenance, as well as surveillance, surveys, communications, search and rescue, cleanup and response. The VTS system alone was estimated to cost RM100 million (about US$28 million) and to involve annual operating costs of RM10.5 million (US$2.8 million). Singapore and Indonesia also incur substantial costs, but systematic information on these costs is unavailable.

As an exercise, it might be useful to put hypothetical dues or fees into some quantitative perspective. For the sake of discussion, assume that the incremental costs (i.e., expenditures beyond those necessary for purely domestic safety measures) of all Straits safety measures are US$100 million per year. To gain some perspective on this, what kinds of dues or fees might be needed to cover this amount each year?

In 1995, some 7 million barrels of oil per day passed through the Straits. Assuming vessels carrying the equivalent of 2% of this amount transit the Straits without stopping, then 2.044 billion barrels per year is delivered to ports along the Straits[23]. A hypothetical fee of as little as US$0.02 per barrel would result in revenue of about US$40 million per year; a fee of US$0.04 barrel would collect revenue of about US$80 million annually.

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[22] *See, for example, Murad (1995), who analyzes the effects of Singapore's traffic separation scheme on vessel accidents in the Straits of Malacca.*

[23] *Table 4.12 in Chua et al. (1997) indicates shipment of 7.7. million barrels/day through the Straits, citing data from the International Petroleum Encyclopedia. It was also noted that 20% of vessels transit the Straits of Malacca without stopping.*

Alternately, consider a hypothetical fee on containers. A fee of, say, US$2 per twenty foot equivalent unit (TEU) on the 4.24 million containers estimated to be delivered to Straits ports through the Straits[24] would result in annual revenues of almost US$8.5 million per year. Finally, a due or fee of US$100 per vessel on the estimated 80,000 vessels yearly calling at the Straits ports for trade would garner US$8 million annually. Obviously, there are infinite combinations of dues and fees that could raise US$100 million.

How might such dues or fees be administered? A uniform fee might alleviate any concerns about changes in the relative competitiveness of Straits ports. Administrative costs for collecting dues and fees would likely be small in total; such costs at least do not seem to be a major issue elsewhere where they are employed. However, administrative costs might fall more than proportionately on the busiest ports, especially Singapore, so for fairness administrative costs might be compensated for out of the collected dues/fees. As discussed, many details would have to be resolved concerning covered vessels, and the distribution of the dues and fees among littoral States would have to be negotiated. These are all important issues, but have not seemed to prevent cooperation among coastal states elsewhere (see discussion in the previous section and in Hamzah, 1997). It is recognized that vessels not stopping at Straits ports likely would not pay any dues or fees.

Vessel Traffic Systems

Vessel Traffic Systems ("VTS") have been defined (Young, 1994) as:

'...any service, implemented by a competent authority, designed to improve safety and efficiency and the protection of the environment. It may range from the provision of simple information messages to extensive management of traffic within a port or waterway.'

Young (1994) points out that the issue with VTS systems is operational, not just information provision. VTS can be used primarily to enhance economic efficiency, to improve safety or some combination of the two. Young (1994) argues that both are objectives in situations where there is much competition among ports, as in much of Asia. VTS watch officers rarely issue orders, except in emergencies. Primarily, they provide information and respond to requests for additional data. VTS also can serve as a valuable "command post" in the event of emergencies, although this is rarely done.

Singapore and Johor and Port Klang have a VTS; and the three littoral States recently have agreed to extend VTS to the Straits as a whole. A ship-reporting system ("STRAITREP") for the Straits recently was approved at the 69th Session of IMO's Maritime Safety Committee and took effect on 1 December 1998. The new system applies to ships

[24] *The figures recognize that an estimated 40% of containers arriving at Singapore use the Straits (Chua et.al., 1997).*

with a gross registered tonnage of 300 GT or more or a length of 50 meters or more, passenger ships and vessels carrying hazardous substances, including oil. The VTS and reporting system will allow shore-based authorities to advise ships transiting the Strait of Malacca and the Strait of Singapore (Golob's Oil Pollution Bulletin, 1998).

VTS increasingly is being used at major ports worldwide, with systems now operating in Europe, the United States and Canada. In North America, several ports have VTS or VTIS, including San Francisco, Seattle, Vancouver, Los Angeles/Long Beach, New York and Delaware. Design and financing of VTS systems is very port-specific, however, and it is difficult to generalize about specific operations and their costs.

VTS systems potentially provide substantial efficiency and pollution management benefits. VTS, however, is by no means a cure all. Generally speaking, in one case study of the port of New York, VTS was found to be very effective for preventing potential accidents at anchorages, but less useful for avoiding incidents for vessels underway when situations develop more quickly than when a vessel is at anchor (Young, 1994). It should be noted that the 1997 *Evoikos* spill in the Singapore Strait occurred while both vessels involved were operating within Singapore's VTS framework. Prince William Sound, Alaska also had a VTS system in place at the time of the *Exxon Valdez* spill.

According to Young (1994), a distinguishing feature of VTS is that much of the interaction between the watchstander and the master of the vessel is by voice radio contact, which is very inefficient. He stressed that this has been found at times to impose great demands upon mariners who must process a great deal of oral information. These problems are likely much more serious in international areas, like the Straits, where multiple languages are the rule, not the exception. VTS still requires masters to operate on line-of-site.

Another issue is that vessels may have different electronic equipment and incompatible systems. The introduction of portable interactive electronic charting and data systems, brought on board by pilots, can address this problem (Young, 1994). A system involving pilots who bring their own, compatible electronic equipment on board is operational in Delaware Bay and appears to be quite successful (Beebe, 1995)[25].

VTS systems are port specific and can be quite expensive in total, if not per vessel served. Indeed, the high cost of VTS caused the United States Congress to scale back on its original goal of using public funds to set up many such systems at ports throughout the United States. The US Coast Guard was urged to work with industry to devise effective systems and measures for their financial support, and has done so in the major port of Los

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[25] *Pilot services in Delaware Bay are not compulsory, but 95% of vessels employ pilots (Beebe, 1995), strong testimony to their effectiveness.*

Angeles/Long Beach, for example. There, much of the operation is undertaken by the private sector; participation of the US Coast Guard allows for regulatory enforcement. A preliminary estimate of the cost of VTS in Malaysia was RM100 million (about US$28 million) for investment costs and RM10.5 million (some US$2.8 million) annually (Muhammad Razif Bin Ahmad, 1997).

An important feature of a VTS is that many of the potential benefits of the system are captured by third parties. Use of a VTS reduces congestion, groundings and collisions and by that pollution and search and rescue costs. Reduced congestion is an external benefit realized by other vessels further back in the queue. Reduced pollution confers benefits upon third parties that would have suffered damages and been less-than-fully compensated.

In summary, a VTS system can create many benefits with respect to increased efficiency, a smaller number of accidents and lower pollution damages. A vessel will capture, as a private benefit, efficiency gains due to more rapid transit and shorter turnaround time in a port due to an effective VTS. However, the vessel is unable to realize any benefits from reduced congestion that other vessels experience, nor will a vessel capture all the benefits from reduced pollution. If only private benefits mattered, a vessel would compare private costs and benefits and make an appropriate decision using market information. However, it appears that external benefits from a VTS can be significant, particularly for the Straits, due to its serious congestion and pollution risks. The more important these external benefits are, the stronger the case for a VTS and for a compulsory VTS. The recently approved ship-reporting scheme in the Malacca Straits appears to recognize the desirability of a VTS framework for the three littoral States.

Other important issues include (1) deciding whether to assess a fee; (2) the fee structure and (3) identification of covered vessels.

Existing financing. Vessels calling at Singapore pay no specific fee for the VTS; costs for the VTS are recovered in port charges. Malaysia appears to use the same financing approach. However, 20% of vessels using the Straits do not stop at any port along the Straits and hence do not support the costs of a VTS.

As with pilotage, discussed above, the three littoral States could strongly recommend that commercial vessels use the VTS. Indeed under the recently passed, vessel reporting scheme, after 1 December 1998 vessels transiting the Straits are expected to report basic information (name, call sign, position, course and speed) to shore-based authorities. Still, some vessels may not comply. Vessels that fail to use the VTS, and are involved in an accident causing environmental damages, might be subject to serious penalties if they subsequently enter the port of a littoral State. Such a policy would encourage reporting and participation in the Straits-wide VTS.

If it were possible to have vessels transiting the Straits without stopping at a Straits port make a contribution, the fees involved might be modest per vessel trip. For example, the Los Angeles/Long Beach VTS levies the charges indicated in Table 2 on covered vessels and varies with the size of the vessel (Actual Length Overall or ALO).

Table 2. VTS Fee Structure at Los Angeles/Long Beach.

Size of Vessel ALO (m)	Fee Per Visit ($)
0-150	180
150-190	200
190-230	230
230-270	270
270-310	300
310 up	340

Source: Board of Harbor Commissioners (1989).

It is clear from the above that for Los Angeles/Long Beach the VTIS fee is low, especially when compared to many port charges that can be thousands of dollars. Modest fees will not affect vessel behavior; fair (user pays), and simple to administer (the vessel's agent can be billed, as in Los Angeles/Long Beach). Although modest per vessel, in total, the amount collected in the Malacca Straits might be several million dollars per year.

Defining covered vessels is an important issue. In Los Angeles/Long Beach, for example, power vessels over 40 meters and vessels issued a certificate to carry 50 or more passengers, whether a power or sailing or regardless of length must pay a fee (Board of Harbor Commissioners, 1989). Frequent visitor vessels, such as fishing boats, passenger ferries, and offshore oil service vessels, pay a modest monthly fee. Fees are seasonal for ferries, and are highest during the peak tourist season ($300 vs. $180 per month). All commercial vessels are assessed a fee based on their size, as indicated in the above table. Vessels simply passing through the Los Angeles/Long Beach VTIS are not assessed a fee. A similar definition for covered vessels using VTS within the Straits might be used, except that vessels that do not stop at any Straits port will not be supporting the cost of VTS, unless some type of voluntary contributions are made[26].

Marine Electronic Highway

Rationale. This system uses sophisticated electronic charting, global positioning systems and real time information on tides, currents and winds to enhance the vessel navigation (Macdonald and Anderson, 1997). The principal advantages of the marine electronic highway (MEH) over a VTS include the fact that an MEH relies on electronic images rather than voice to convey information, and it integrates information in a single

[26] *It is recognized that voluntary payment by vessels as suggested above for use of VTS raises several practical (and perhaps legal) issues. The financing options suggested under navigational aids also might warrant consideration for VTIS.*

electronic chart, as compared with the current system used by most vessels, which requires the master to move between different charts. On board electronic charts, however, can be expensive for vessels.

Still, mariners will need radio contact for updates on information, when there is equipment failure, in emergencies or to ask for advice. Hence, VTS and MEH are likely to be complementary and not substitutes.

An MEH promises substantial benefits from (Macdonald and Anderson, 1997):

1) Reduced chance of groundings, collisions and other accidents, avoiding the costs associated with such incidents;

2) Lower transportation costs by allowing vessels to carry more cargo, if the existing minimum keel clearance of 3.5 meters for the Straits can be relaxed; and

3) Permitting some vessels which now avoid the Straits to use the Straits, incurring less costs.

Sustainable Financing for an MEH. Cost of charts and on-board equipment would be borne by individual vessel owners. Infrastructure costs, however, would be considerable and hydrographic data would have to be updated, which is expensive. This has not been a problem at the national level, but is an issue for international straits.

It is unlikely that fees could be levied and enforced on all vessels due of the provisions of UNCLOS Article 43. Four alternative possible financing solutions are noted. One is use of the Global Environment Facility (GEF) to cover the incremental costs of an MEH. Some of those involved with promotion of an MEH for the Malacca Straits are optimistic that GEF would look favorably on a proposal for the Straits. What is unclear, however, is how incremental operating costs might be covered, and whether the GEF would provide for periodic maintenance and updating of the system, and do so over a prolonged period.

Shore Reception Facilities

Operational discharges of oil and grease from ships have been identified as a pollution problem in the Straits (Calow and Forbes, 1997). Garbage, plastics and other wastes are additional issues. Crew members generate several pounds of waste per day; thus a single vessel with a crew of 25 can be expected to generate a hundred pounds or more of garbage daily. With many tens of thousands of vessels transiting the Straits each year, inappropriate or illegal waste disposal at sea or in ports can be a serious marine environmental issue.

Under MARPOL Annexes I-V, vessels are prohibited from discharging most wastes at sea. Table 3 shows the MARPOL Annexes and whether or not they have been adopted

Table 3. MARPOL Annexes and Ratification Status for the Straits of Malacca Littoral States.

Annex-Waste Covered	Indonesia	Malaysia	Singapore
I/II Oil and noxious liquid substances	Yes	Yes	Yes
III Harmful substances carried in packages	Yes	Yes	Yes
IV Sewage			
V Garbage	No	Yes	Yes

by the three littoral States.

Shore reception facilities are intended to receive and safely dispose of bilge and oily waste waters, hazardous materials, and plastics and garbage. Reduced discharge of wastes from shipping improves environmental quality, a public good from which all can benefit.

Shore-based reception facilities can be a private or public sector activity, but normally is a partnership between the two. To recover costs, however, the scale of activity and the fees assessed must be adequate to ensure that revenues exceed costs. This can be serious problem for small ports. Further, the shoreside waste contractor must be reputable and exercise due care so that the disposal of wastes at shore simply does not transfer the waste disposal problem to another location, affecting onshore or indirectly coastal resources. For those ports where size is a problem, one suggestion is that the various terminal operators cooperate and use a single reception facility for receiving wastes (Roos, 1997).

Important problems also can arise due to the nature of the wastes. If garbage contains agricultural wastes, for example, then inspection by national agricultural authorities may be required prior to disposal to ensure that such wastes do not introduce new pests to the country. Or, if hazardous materials are to be discharged, special facilities and handling may be needed to avoid later pollution problems at landfill sites and surrounding areas.

A major probable concern is ensuring that vessels making port calls actually use port reception facilities (Roos, 1997). A vessel operator's use of reception facilities entails two costs: cost of the service and cost for use of reception facilities. Use of explicit fees will have users pay, but may reduce compliance. Experience in Germany, for example, found that vessel operators were sensitive to the fee charged. In a pilot program, compliance at the port decreased dramatically when a temporary, free-of-charge approach was ended and a fee was levied (Roos, 1997). It is difficult to generalize from one report, but this suggests a fee must be low, or lumped in aggregate port charges so as not to be apparent. Singapore,

for example, collects garbage with no explicit charge for this service. Roos (1997) reports that in Germany, waste reception costs have become part of a cargo fee levy.

The cost for use of reception facilities results from any added time in port due to waste disposal activities[27]. This can be a major cost because of the high value associated with a vessel's time (likely US$1,000 or more per hour).

Accepting the relevance of the above points, compliance will be greater if ports use lower fees and provide for the timely transfer of wastes. The disposal fee may be part of the overall port use fee, as is apparently the case in Singapore and in Germany, so that in these ports, the additional fee for waste removal is not viewed as a separate cost. For garbage, ports might arrange for the wastes to be collected while vessels are at anchor or use other approaches to eliminate or minimize time in port due to waste transfer activities. Commercial operations may be encouraged, but will have to meet the criteria of low fees and quick turnaround, otherwise vessels may illegally dispose of wastes in the Straits. In all cases, advance notice about the availability of waste reception facilities should be provided.

To enhance further participation in waste reception activities, port officials could require proof of proper discharge and inspect vessels for adequate waste storage capability. Penalties could be levied for inadequate facilities or records. This apparently is being done in some locations (Roos, 1997). Also, vessels caught illegally disposing of wastes could be assessed heavy penalties[28].

Private participation is enhanced by combining waste streams from different sources to ensure an adequate scale of operations. This might also improve the economics for recycling certain wastes. Public bidding by qualified contractors and oversight of contractors performance and fees are other important elements of a successful private-public partnership (Ross et al., 1997).

It is recognized that the above discussion does not address vessels that transit the Straits without calling at any port.

Potentially Profitable Partnerships

In the previous sections, several cooperative approaches were outlined. Several services and their existing and potential financing were also discussed.

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[27] *Vessels also incur costs for on-board storage and handling of wastes. Cruise ships, which generate enormous volumes of waste, incinerate wastes to avoid high waste storage costs and health threats.*

[28] *Shame often is a deterrent, and another penalty might involve requiring offenders to take out a major advertisement in the newspapers acknowledging their environmental indiscretions, as has been done in some countries.*

This section provides a simple framework using standard, discounted cash flow (DCF) techniques that can be used to assess whether a particular investment is economically attractive. Then, potentially attractive investments are discussed for several services. Given the lack of data and the specialized nature of the issues, the discussion is necessarily somewhat general.

Framework for Assessing the Attractiveness of Investments

This section provides a framework for evaluating the financial attractiveness of potential investments. First, a framework based on DCF analysis is provided, a generally accepted approach for evaluating the feasibility of a proposed investment project. Next, aspects of investment risk are discussed. Risk (variations in returns) is a very important issue when assessing the attractiveness of any private investment, but is particularly important when weighing investments in prevention and control of wastes from shipping, especially in countries where funding sources and experience may be limited.

For the private sector, an attractive investment is one which yields investors (1) a positive net present value (NPV) or (2) an internal rate of return (IRR) that is greater than a business' weighted average cost of capital (WACC). A firm's WACC includes the cost of long-term debt and equity sources of financing, each weighted by their importance in a particular activity[29].

To assess the attractiveness of potential investments, this report recommends the use of the NPV and IRR for each potential investment, although data limitations prevent an actual analysis of specific projects in this report. The NPV and IRR are standard concepts used to assess the feasibility and return on investments; but given their importance, these concepts should be explained in some detail.

An attractive private sector investment has a positive NPV:

$$NPV = -I_0 + \sum_t (R_t - C_t)/(1+r)^t + S_T/(1+r)^T > 0$$

where:

I_0 = Initial investment required

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[29] *Strictly speaking the relevant cost for each capital source is its after-tax cost; and the weights attached to each source are to be measured at the "optimal" financing mix. For example, cyclical businesses (most natural resource businesses and durable goods) have a lower debt/equity ratio than a business with stable earnings (e.g., water and electricity utilities).*

R_t = Revenue from activity at time t

C_t = Annual operating and maintenance costs

S_T = Salvage value (or Shutdown costs) at the end of the project life

r = Discount rate (equal to a business' WACC)

T = Terminal year

Alternately, an attractive private investment will result in an IRR > r = WACC. The IRR measures the rate of return earned by an investment. It is estimated by solving for the discount rate, r, in the above equation that sets the NPV equal to zero. For example, assume that a firm has a WACC of 14%, and that a discount rate of 20% just sets the NPV for a particular investment equal to zero. The IRR, in this case, is 20%. Since the WACC is 14% and the yield is 20%, the investment is a good one from a private investor's point of view.

For independent investments (e.g., a new waste reception facility and an additional aid to navigation, such as buoys), a positive NPV implies that IRR > WACC = r, in the above equation. Hence, in the case of independent investments, either NPV or IRR can be used and will give the same result concerning the attractiveness of a project. However, for mutually exclusive investments, such as two competing aids to navigation (an either-or choice), or two mutually exclusive uses of the same port land, NPV and IRR may not give the same outcome, in which case NPV is the correct criterion to use for maximizing total profits (or wealth).

The outcome of an investment rarely is known with certainty. Hence, uncertainty and attitude toward risk are important considerations for many private investments. Below, the two concepts interchangeably are used, but strictly speaking uncertainty refers to situations where multiple outcomes and their associated probabilities are known beforehand. Risk, on the other hand, applies to cases where multiple outcomes are known but their associated probabilities are not objectively known; subjective probabilities based on expert judgment, for example, must be used instead in these cases. Hereafter, we use risk in the general sense of variability of anticipated returns.

Risk is especially important for investments in new (or relatively new) activities—such as many waste management proposals. Two sources of risk are noted: business risk and financial risk. Business risk basically includes all of those factors that could cause net returns in each period to vary. These factors include the cyclical nature of the activity, its market and the effectiveness of managers, for example. No private sector activity can fully avoid business risk, although actions to form cooperatives, purchases of insurance and use of futures markets are typical devices businesses use to hedge against risk. Governments

can spread risks among many millions of citizens, so that even a very large loss may be negligible to an individual citizen. However, a company—especially smaller ones—has fewer opportunities to share risk. Hence, governments normally are less concerned with risk, i.e., governments can be viewed as risk neutral, as compared to individual private operators.

Financial risk arises from the method used to fund the enterprise, i.e., long-term debt (mortgage, notes, bonds, etc.) or equity (stock issues, owner equity). For example, excessive reliance on debt (i.e., use of leveraging) leaves firms very vulnerable to bankruptcy in the event of below-normal revenues. This happens since debt requires companies to make fixed interest payments, something they may be unable to do if sales are below expectations for some period. Businesses can avoid this financial risk by relying upon equity, but even 100% equity financing cannot avoid business risk inherent to any enterprise.

Risk can be taken into consideration in many ways. In this report, breakeven analysis and sensitivity (what if) analysis are considered. Break-even analysis is useful in that it provides an estimate, for example, of the minimum scale of activity needed to make an investment feasible. For any potential investment, we can estimate the minimum, annual quantity of the activity required in order for the project to break even, all other things being the same, such as the unit fee or unit cost. Breakeven is defined as a NPV = 0 or IRR = r = WACC. Assuming that the unit fee ("f"), the level of activity ("q"), and the unit operating cost ("c") are constant, and net salvage value or net shutdown costs (S_T) are zero (or are offsetting), the *breakeven* NPV is:

$$NPV = -I_0 + \sum_t (fq_t - cq_t) \Big/ (1+r)^t = 0, \text{ or}$$

$$NPV = -I_0 + q(f-c)\sum_t 1 \Big/ (1+r)^t = 0$$

To estimate the minimum scale, q, we rearrange terms:

$$q = I_0 \Big/ (f-c)\sum_t 1 \Big/ (1+r)^t$$

Thus, to determine the breakeven level of operation, q, we need to know each piece of information in the formula given immediately above.

In many cases, it also may be important to understand how the outcome might change if an alternative assumption about the scale, fee or investment or operating cost is used. Sensitivity analyses can be a very useful tool for this purpose. To be most useful, those factors that are uncertain and thought to be important need to be considered. To apply this approach, one might see how the outcome obtained using the above NPV formula changes if the unit cost is higher than expected, or if q is lower than anticipated, for example. If the results are very sensitive to a particular assumption, then additional research might be done to refine the estimate for that particular item[30].

Potentially Attractive Private Investments in the Straits: Discussion

Shore Reception Facilities. As described earlier, shore reception facilities are intended to receive and safely dispose of bilge and oily waste waters, noxious materials, plastics and garbage. For a private investment to be made, one important issue for cost recovery is whether the scale of disposal operations at a port is adequate to pay off all costs and yield a normal rate of return (one equal to r or the WACC). In many cases, where the scale of wastes from vessels do not allow economies of scale to be achieved, it may be necessary to combine waste collections from vessels with waste disposal from land-based sources (Roos, 1997).

Cost data for waste reception facilities in the Straits are not available and would vary by type of waste handled. However, general cost information for waste reception facilities in one port in Germany given in Roos (1997) reinforces the point made above that the unit cost of some recovery operations can be very high, unless sufficient scale is achieved. For example, in the German case considered by Roos (1997), the implied costs per disposal operation for MARPOL Annex I wastes is over $2,000. However, only 10-12% of the vessels used the facilities, so a reasonable scale of operation was not achieved. Unit costs were lower at Bremerhaven, a large port where the scale was much greater.

To illustrate the breakeven methodology previously outlined, assume a waste reception facility *hypothetically* costs US$2 million ($I_o$) for collection vehicles, receptacles and land; the fee is US$400 per ton (or cubic meter); and the operating cost for collection, handling and transport to a landfill is US$100 per ton. Using a discount rate of 10% and a ten-year life, the breakeven annual q is:

$$q = 2{,}000{,}000 / (6.145)(400-100) = 1{,}085$$

Hence, if vessels on average had 2 tons of a waste per call at a port, then annually the equivalent of a minimum of 543 vessels (1.5 per day) using the facility would be required to

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[30] *Simplified approaches are suggested in this report. However, in particular cases when the stakes are high use of more sophisticated approaches involving expected values, including Monte Carlo techniques, may be warranted.*

make this an attractive investment, under the assumptions indicated. For some perspective, most moderate sized ports have many more than 543 vessel calls per year. Still, the amount of particular wastes generated per vessel is a critical piece of information and is not known for Straits ports.

Two sensitivity analyses are used for illustration. First, assume that initial investment costs are $1.5 million rather than $2 million. In this case, the break-even q decreases to 814 tons. Alternately, assume that the operating margin (f-c) is $200, rather than $300. Here, the break-even q would increase to 1,628 tons. Thus, given reasonable estimates of the indicated, required data, sensitivity analyses could be used to explore the feasibility of private investments in shore waste reception facilities.

Obviously, in particular cases, the specific costs, requirements, vessel traffic and the quantity and nature of wastes generated would need to be examined closely. Another site-specific issue concerns whether recycling of collected wastes is a viable alternative. To the extent wastes have a market value, they will reduce costs and the minimum scale required, by that enhancing the opportunity for attractive private investments. The methodology outlined above can be used to solve for the minimum fee, the maximum operating cost, or the maximum initial investment outlay in order to at least break even[31].

Vessel Traffic Information Systems. VTIS fees, in ports like Los Angeles/Long Beach, are set to cover costs. As noted in the earlier discussion on VTIS, critical issues include the fee structure and the definition of covered vessels. The specific fees, in turn, will depend upon the costs associated with a particular port and the volume and type of traffic. For example, ports can differ substantially in terms of the number of radar stations and their associated manning requirements.

An important financing factor concerns public-private arrangements at particular ports. The Los Angeles/Long Beach VTIS case, for example, involves both US Coast Guard personnel and private sector pilots. This cooperative arrangement was made in part to reduce the need for public financing. The employment of pilots makes use of their extensive local experience and reduces public costs. The involvement of the Coast Guard provides an official regulatory and enforcement element.

Rate setting is an additional issue. As noted, Singapore does not levy a specific fee for use of its VTS, while Los Angeles/Long Beach set rates that differ by category of vessel, size and in some cases, time of year (see earlier discussion). To set rates in a particular case, trial and error and judgment would be needed to devise the set of fees that would be fair, politically acceptable and recover costs.

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[31] *Tax issues and the cost of special permits and fees somewhat complicate the calculations but these can be considered in particular situations.*

Despite the seeming complexity of the fee structure issue, the basic framework for assessing profitability, set out above, could be employed, after suitable modification. However, instead of a single fee with a total revenue R = fxq, as given in the above formula, a set of fees f_1, f_2, ..., f_n is needed, one for each category of vessel q_1, q_2, ...q_n, where each q is a different vessel category/size for covered categories of vessels. Basically, for each year of operation one must calculate: $R_t = f_1xq_1 + f_2xq_2 + ... + f_nxq_n$ which, when appropriately discounted[32], would just cover the present value of costs. This exercise would involve some trial and error, but would not be too onerous. Again, the rates per vessel would be low, so that there would be a negligible effect on use of the VTIS in the Straits.

Marine Electronic Highway. Although no financial assessments of MEHs are publicly available, private sector activity potentially could be an important element of an MEH. On the demand side, individual vessels might realize large benefits from participation in an MEH due to enhanced safety, less down time due to bad weather and the ability to carry larger loads. However, an effective MEH requires precise hydrographic data, which can be costly to gather and largely has been provided by national governments. One proposal is that littoral States participating in data gathering and sharing would be compensated for international cooperation by receiving royalty revenues from vessel operators for data usage.

At the same time, many firms now provide real time weather and related data electronically, for a fee. This demonstrates the commercial value of information and that there is a basis for private sector involvement in the production of updated, precise data necessary for an effective MEH. Further, advanced methods for obtaining hydrographic information at lower cost, using laser-based technology, may also provide for private sector financing and involvement (Wellington, 1997). This suggests that greater private involvement on the supply side may occur in the future.

Beyond private benefits to vessels, an MEH will create broader, external benefits that cannot be captured by a participating vessel. This occurs when an MEH reduces delays due to congestion or lowers the risk of accidents and spills. It is unclear, however, whether fees that vessels would be willing to pay (based on their private benefits) for MEH data would be adequate to cover ongoing costs of an MEH. Further, high fees may discourage vessels if the higher fee exceeds private benefits from using an MEH. If external benefits from an MEH are important, one does not want to discourage vessels from using an MEH. This suggests that careful attention must be given to an appropriate fee structure. For example, prevailing port fees typically increase with the size of the vessel and the type of cargo. Vessel size and cargo may also be an important factor to allow for in setting fees with an MEH. Designing a possible differential fee structure for an MEH adds complications that are beyond the scope of this report.

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[32] *Note that 't' has been dropped for convenience but must be considered.*

Finally, countries that are major beneficiaries of the Straits sea lanes might provide some support for an MEH. Even though the MEH has important elements of a public good, some countries may capture sufficient benefits to justify some support, rather than go without MEH.

Salvage Operators. Salvage operations involve those activities undertaken to save a vessel or control the consequences of an accident. Business risk is a major fact of life for salvage operators. They must invest a substantial sum in equipment, and their income depends upon being compensated for providing services following accidents—which by definition are chance events and hence difficult to plan for. Risk in and of itself is not a market failure; many businesses deal with risk all of the time through insurance, future markets, joining cooperatives and so forth.

Important issues for salvors are: (1) risk sharing and (2) market failure. Risk sharing in practice seems to have put salvage operators in a disadvantageous position. Correcting this issue may help prevent and control pollution from shipping with associated societal benefits and create potential private investments. Market failure also seems to be an issue, due to a lack of well-defined property rights and of certain contractual enforcement in some cases. For markets to serve their function, property rights must be well defined and readily enforceable through contracts. This appears not to have been the case for salvors operating in the Straits and elsewhere.

Beyond the chance nature of accidents, several other types of risk affect salvage operations. One important source of risk stems from the fact that payment may depend upon the success of the salvage operation, captured in the well-known 'no cure-no pay' clause in standard Lloyd's Open Ended forms—and success (cure) cannot be guaranteed. Beyond that, salvage companies are not always certain that they will receive compensation, even for their successful actions[33]. For example, disputes among the various interests (owners of cargo and owners of the hull) about appropriate salvage actions, may lead them to contest payments, by that causing a delay in payment to salvors and forcing them to incur legal costs to pursue compensation. There seems to be an important legal issue with significant policy implications concerning a salvor's ability to be rewarded with compensation for preventing losses to the environment as well as to property (Girvin, 1997). Also, in some cases salvage operators may need specific authorization from P&I officials in London to undertake a salvage action. Yet, it may take time in some cases to gain formal approval from P&I officials. For example, in the case of the *Evoikos* spill, it took some eight hours to get approval for actions. Delays can pose a serious threat to the environment and other resource uses.

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[33] *In the case of oil spills, compensation for actions is more likely, for example, given strict liability under inernational conventions ratified by member countries.*

Salvage operations clearly are an important service for preventing and controlling marine pollution from shipping. The business risk issues noted above, however, appear to prevent the market for salvage services from operating efficiently. This is particularly true for independent vessels, as opposed to vessels that are members of cooperatives, such as EARL, which provide response services to members, but will service non-members only on an as-available basis. Hence, the salvage sector to some extent suffers from market failure and institutional failure.

Several measures might help make the market for salvage services more efficient, by that better preventing and controlling marine pollution from shipping. Greater use of a revolving fund would remove some risks in many cases. For example, when there would be a delay in salvage actions due to problems with reaching a P&I representative, uncertainty for national authority for particular spills, or delays by the vessel operator in identifying a response organization, then the fund might step in and pay for interim actions, with later reimbursement from the P&I. Also, given the potential problem with independent vessels, all vessels might be advised that they must have a response plan in advance of a spill, including the name of a response organization. These measures would help avoid delays in response and therefore help prevent or control spills. They would also help reduce uncertainty for salvage operators, by that reducing business risk and enhancing the prospects for private investment in this activity.

A very important issue for salvors in the Straits (and indeed worldwide) concerns the scope and size of rewards for salvors' successful actions to protect the environment in addition to property, as arose in the *Nagasaki Spirit* incident and the subsequent legal case (Girvin, 1997). This last issue raises legal and policy concerns beyond the scope of this report.

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