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Pollution Generated by Ships – an Issue That Should be Kept Under Control

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Abstract: Ships pollute the world's oceans in different ways. Oil spills coming from merchant ships can have devastating effects to the marine environment. It is well known that the components in crude oil are very difficult to clean up, and last for years in the sediment and marine environment. Also, accidental or intentional discharge of cargo residues from bulk carriers can pollute the world's oceans. In many of the cases of water pollution, vessels intentionally discharge illegal wastes despite foreign and domestic regulations that prohibit these particular actions. Another kind of pollution coming from merchant ships that also should be taken into consideration is represented by the noise pollution that disturbs natural wildlife, and water from ballast tanks which can spread harmful algae and other invasive species.

Ships' pollution has become a problem ever since shipping trade has become increasingly global, posing an increasing threat to the world's oceans and waterways as globalization continues. Due to a high rate of commercial traffic in ocean ports, pollution from ships also directly affects coastal areas.

In this paper we are trying to point out several important issues related to pollution as a result of ships' operations but also to give several solutions for reducing the amount of pollution coming from vessels.

Keywords: ship, pollution, solution, oil spill, ballast water, ocean

1. INTRODUCTION

Ships' pollution is represented by the pollution of air and water by shipping. Due to shipping globalization, it is expected a great amount of pollution generated by this industry. It is also expected that shipping traffic to and from USA will double by 2020. Because of increased traffic in ocean ports, pollution from ships also affects directly the coastal areas. The pollution produced affects the biodiversity, the climate, the food, and human health. However, the degree to which shipping is polluting and how it affects the world is highly debated and has been a hot international topic for the past 30 years.

Spills from oil tankers and chemical tankers, and ejection of sulphur dioxide, nitrogen dioxide and carbon dioxide gases into the atmosphere from exhaust fumes have a great impact on environment worldwide. Discharge of cargo residues from bulk carriers can pollute ports, waterways and oceans. Ships create noise pollution that disturbs natural wildlife, and water from ballast tanks can spread harmful algae and other invasive species. In many instances vessels due to a variety of reasons intentionally discharge illegal wastes despite foreign and domestic regulations prohibiting such actions.

2. SOURCES OF POLLUTION FROM SHIPS

2.1 Ballast Water

When a large container ship or a tanker unloads cargo, seawater is pumped into compartments in the hull. Similarly, when a larger vessel is being loaded it discharges seawater from these compartments. The sea water is meant to help stabilize and balance a ship. Ballast discharges from ships are responsible for tar balls in the open oceans and seas, and can cause problems for navigating tanker routes. Nevertheless, the discharge of ballast water only accounts for a small percentage of oil pollution in the marine environment.

Ships are also responsible for transporting harmful organisms in their ballast water. This is one of the worst cases of a single invasive species causing harm to an ecosystem.

In addition to introducing non native species into new environments, ballast and bilge discharges from ships can spread human pathogens and other harmful diseases and toxins potentially causing health issues for humans and marine life alike. Discharges into coastal waters along with other sources of marine pollution have the potential to be toxic to marine plants, animals, and micro-organisms causing alterations such as changes in growth, disruption of hormone cycles, birth defects, suppression of the immune system, and disorders resulting in cancer, tumours, and genetic abnormalities or even death. They may also have the opposite affect upon some marine life stimulating growth and providing a source of food. Sources of seafood can become contaminated and unhealthy for consumption. As the demand for waterborne transport increases in the future, the potential for loss of critical or valuable regional species will increase as well.

2.2 Exhaust Emissions

Exhaust emissions from ships are considered to be a significant source of air pollution, with 18-30% of all nitrogen oxide and 9% of sulphur oxide pollution. The 15 biggest ships emit about as much sulphur oxide pollution as all cars combined. By 2010, up to 40% of air pollution over land came from ships. Sulphur in the air creates acid rain which damages crops and buildings. When inhaled the sulphur is known to cause respiratory problems and

even increases the risk of a heart attack. The fuel used in oil tankers and container ships is high in sulphur and cheaper to buy compared to the fuel used for domestic land use. A ship lets out around 50 times more sulphur than a lorry per metric tone of cargo carried. Increasing trade between the U.S. and China is helping to increase the number of vessels navigating in the Pacific and exacerbating many of the environmental problems. The number of voyages is expected to continue increasing. 3.5% to 4% of all climate change emissions are caused by shipping.

2.3 Oil Spills

Most commonly associated with ship pollution are oil spills. While less frequent than the pollution that occurs from daily operations, oil spills have devastating effects. While being toxic to marine life, polycyclic aromatic hydrocarbons (PAHs), the components in crude oil, are very difficult to clean up, and last for years in the sediment and marine environment.

Marine species constantly exposed to PAHs can exhibit developmental problems, susceptibility to disease, and abnormal reproductive cycles. One of the more widely known spills was the Exxon Valdez incident in Alaska. The ship ran aground and dumped a massive amount of oil into the ocean in March 1989. Despite efforts of scientists, managers, and volunteers over 400,000 seabirds, about 1,000 sea otters, and immense numbers of fish were killed.

2.4 Aiding Cloud Formation

For most of the rest of the northern hemisphere oceans, ship emissions are responsible for greater than 30% of the predicted SO2. And in the southern hemisphere, ship contributions are generally less than 5%, except over large areas north and east of Australia where they contribute between 10 and 20%. The researchers say that comparison of their modelling results with actual SO2 observations strengthens their conclusion. Emissions from shipping can also have a marked effect on land, particularly in the form of acid rain. This is no surprise, as nearly 70% of ocean-going ship emissions occur within 400 km of land.

An important effect of ships' sulphur is the increase in the available nuclei upon which cloud drops form. The researchers say the change in global atmospheric heat balance caused by the clouds which result from shipping emissions is appreciable. They put it at 14% of the estimated change caused by all sulphate from human activities. Sulphur emissions have a large role in the formation of aerosols, or tiny particles, on which water condenses to form clouds. The interactions of aerosols and clouds have been identified as one of the most important uncertainties in understanding the rate of climate change. This is because clouds reflect energy and thereby reduce the net warming effect of long-lived greenhouse gases.

Aerosols survive in the atmosphere for about a week, compared with decades and centuries for greenhouse gases. The researchers think their work on the contribution of shipping emissions may shed light on how aerosols behave.

2.5 Dredging for Vessel Access

There is an additional environmental problem that might be considered an infrastructure issue, but it is linked directly to the superstructure requirements of the waterborne mode. For vessel access to the port or terminal facilities a depth of water in excess of the draught of the vessel is required. In all ports but those benefiting by naturally deep access, or where currents continually scour the bottom preventing the build-up of sediment, the dredging of the access, usually on a recurring basis, is necessary. This process significantly alters

the natural balance of the marine ecosystem over the length of channel or berth that must be maintained in this way. As deeper draught vessels are developed as a response to carry greater quantities of freight, and as the need is felt to allow such vessels to sail further up shallow estuaries or rivers, the issue of dredging takes on an increased importance and there are other aspects of dredging that are cause for concern. The sediments that are deposited along the bottom of rivers that flow through industrialized regions have through the years been contaminated with toxic residue-most notably heavy metals. These residues in the past have been responsible for the contamination of the waterways has been curtailed by the elimination or control of point source discharges from industries that produce such harmful by-products. Over time the natural sedimentation process at work in many waterways has buried these toxic materials at sufficient depths to shield the bottom dwelling marine life from the toxic effects, allowing a natural recovery. To now dredge up these areas exposes the marine life in the area again to the same habitat destroying toxins. Even though the sediment may be removed from the bottom of the waterway, the process releases this toxic material to the downstream areas that are not dredged. The environmental problems associated with the dredging process extend beyond the concern for the bottom of the water course. Once this material has been removed, it must be disposed of in an environmentally acceptable manner. This material is normally used for landfill applications ashore. However, when this material is contaminated with toxins and heavy metals, the leaching of the materials to ground water sources or inland streams, lakes or reservoirs spreads these persistent forms of contamination to new locations. It is estimated that more than 200 million of tones of dredged material is dumped at sea each year.

2.6 Marine Growth on Vessel Hulls

Related to the problem of toxic materials in bottom sediments is the contribution from the materials applied to the bottom of vessels to retard or prevent the accumulation of marine growth. For maritime transport to be able to move efficiently and avoid the unnecessary burning of fuel, the build-up of marine growth must be avoided. In the past, this problem was intended to be solved by adding to the paints arsenical or mercurial compounds or even pesticides such as DDT. By the 1970s, the industry developed more effective anti-fouling paints using other metallic compounds, in particular the Tributyltin (TBT) considered at that time less harmful than the arsenical and mercurial compounds (the DDT had been banned in many countries by 1973).

While these materials have proven rather effective in providing a clean underwater hull, they have contributed steadily to the accumulation of the toxins from the paint in the surrounding waters where vessels transit, moor and undergo repairs. The toxins from these paints steadily leach into the environment and are deposited whole scale into the surrounding waters when the adhesion of the paint to the hull breaks down or the bottom paint is mechanically removed without the collection of the residue. The result has been a steadily expanding plume in the water around port areas rendering the water and sediments unable to sustain the basic components of marine life that are critical to the marine food chain. Options are needed to reduce the introduction into the water of such toxins. Safe hull cleaning methods are needed as well s the introduction of coming technology to employ coatings that are naturally resistant to selected marine growth without the potential for overall harm to the surrounding marine ecosystem.

2.7 Chemicals in Portable Tanks

Portable tanks that have been designed for maritime transport of hazardous materials present a significant concern. As the industrialization process gathers momentum in

the countries now regarded as having developing economies, there will be an increased need for a large variety of Chemicals that pose significant environmental threats when transported by such tanks in concentrated forms. This includes the chemicals needed to support agricultural growth through pesticides, herbicides and fertilizers and the chemicals needed to support manufacturing and fabrication processes. The safe and sensible use of such chemicals is beyond the purview of those who are supplying the means of transport. However, there is an obligation on the part of those supplying the means of transport to see that the transportation process does not stimulate harmful environmental practices. The cleaning of chemical tanks once they are emptied to reduce the hazard they present is a common practice. It is also done to allow the return shipment of a tank at a reduced rate if it does not contain a hazardous material. The prospect exists for tremendous numbers of such tanks to be cleaned in hinterland areas where there exists no means to dispose of highly toxic and polluting residues.

In many parts of the world the common practice is already to dispose of the residues directly onto the ground or into the waterways.

2.8 Reception Facilities for Vessels

The movement of hydrocarbons and chemicals by the waterborne mode poses an inherent risk to the marine environment. This risk arises not just from the potential for a massive accidental discharge, but also from the more routine discharges associated with operational activities. It has been estimated that only one quarter of the oil introduced into the water from ships is the result of accidental discharges. To address the pollution potential from operational discharges an extensive regulatory system has been established. At the heart of the approach has been a prohibition for the discharge of hydrocarbons and chemicals into the water from vessels. They have been required to retain such accumulated wastes aboard until they can be discharged ashore. Vessels that must have the permission of governments to operate have been forced to make the alternations to vessel design and equipment to comply with such regulations. However, these same governments that should provide facilities ashore for the reception of these accumulated materials have failed to make such facilities available in many port areas. Part of the reason for this is the failure of some governments to back voiced environmental concern with budget actions to support the key element of the environmental protection system they have established for vessel operators. Other approaches have been to provide facilities only in the port areas that receive large enough volumes of vessel traffic to justify the investment in reception facilities. The result has been that a global mechanism to preserve the marine environment has actually worked to the environment's disadvantage. Hazardous residues that previously were discharged in open waters are now retained until the more environmentally sensitive near-shore waters are reached and, in the absence of adequate reception facilities, are often eventually discharged nearer to shore on the approach to or departure from many of the world's ports. As numbers and size of ships increase to meet future consumer transport demand, this lack of reception facilities becomes a problem of ever increasing proportion. While the increasing traffic levels may mean that more ports will begin to justify the provision of facilities, this approach also ensure that newly developed ports, or small growing ports will not receive the facilities to protect their environment until such time as vessel traffic levels have already increased to the point where they have sustained significant environmental degradation. So far the reception facility issue has only been discussed in terms of residues of hydrocarbons or chemicals. While these substances may represent the issue of greatest current concern, the same reception facility mechanism and problem associated with these materials also applies to shipboard generated garbage and sewage. For all of these materials

a different systems approach is needed that will allow the preservation of the existing unpolluted and uncontaminated marine areas as they begin to develop in response to growing global transport needs.

2.9 Containerization of packaged hazardous materials

The growth in the movement of freight within containers has brought with it new environmental concerns. Very concentrated forms of toxins and other hazardous materials can be shipped in small packages and these more and more frequently within containers. Detailed regulations have been developed to try to ensure that such materials are not stowed or stacked next to other materials which could have serious results such as fire, explosion, or the release of poisonous vapours if the different types of materials become mixed. These regulations are very detailed, but also very complicated for untrained personnel to apply. The result has been a steady increase in detection of containers with improper stowage of such hazardous materials, and an increase in the number of hazardous material incidents that are taking place when such materials break free within a container. As the demand for transport of such goods increases, the potential increases for more and worse disasters that can have devastating effects on personnel and the environment. Response to these types of hazardous material incidents is most often by a local fire brigade; and, even in industrialized countries today it is only in the larger fire response organizations where trained expertise is readily available to make a proper and effective response. Where training and equipment is lacking, the normal response of persons trained to fight fires is to hose the scene down with water. While in some situations this may in fact be the best response, in other situations it may in fact be the worst response. Some materials may react with the water resulting in rapid oxidation of the material or the release of poisonous fumes. Perhaps the worst possibility for the environment is the tendency for such spilled materials to be flushed with fire hoses into the nearest ditch, stream or storm drain where, depending on the material, it can destroy any marine life over a large area for years. Persistent materials may infiltrate the human food chain and cause congenital problems that do not become apparent for decades.

2.10 Pollution by Dumping at Sea

On 13 November 1972 it was adopted in London, in the framework of an Inter-Governmental Conference the "Convention on the prevention of marine pollution by dumping of wastes and other matter", generally known as London Convention (LC). The main objective of this convention is to promote the effective control of all sources of pollution of the marine environment by the dumping of waste and other matter. For the purposes of the convention, dumping is defined as the deliberate disposal at sea of wastes or other matter from vessels, aircraft, platforms or other man-made structures, as well as the deliberate disposal of vessels or platforms themselves. The Convention has been amended to include the incineration at sea, list of substances concerned to incineration, the ban of dumping into the sea of low level radioactive wastes, the phase out of dumping of industrial wastes and the ban of the incineration at sea of industrial wastes. The main purposes of this convention are to prevent the pollution of the sea by the prohibition of dumping of the following substances and/or wastes: Organohalogen compounds, Mercury and its compounds, Cadmium and its compounds, Persistent plastics and other persistent synthetic materials, Crude oil, fuel oil, heavy diesel oil, and lubricating oils, hydraulic fluids, any mixtures containing any of these, High-level radioactive wastes or other high-level radioactive matter, materials in whatever form produced for biological and chemical warfare.

2.11 The Amount of Pollution from Ships

Britain and other European governments have been accused of underestimating the health risks from shipping pollution following research which shows that one giant container ship can emit almost the same amount of cancer and asthma-causing chemicals as 50000 cars.

Data from maritime industry based on engine size and the quality of fuel typically used by ships and cars shows that just 15 of the world's biggest ships may now emit as much pollution as the entire world's 760mill cars. Low-grade ship bunker fuel (or fuel oil) has up to 2,000 times the sulphuric content of diesel fuel used in US and European automobiles.

Pressure is mounting on the UN's International Maritime Organization and the EU to tighten laws governing ship emissions following the decision by the US government to impose a strict 230-mile buffer zone along the entire US coast, a move that is expected to be followed by Canada.

The setting up of a low emission shipping zone follows US academic research which showed that pollution from the world's 90,000 cargo ships leads to 60,000 deaths a year in the US alone and costs up to $330bn per year in health costs from lung and heart diseases. The US Environmental Protection Agency estimates the buffer zone, which could be in place by next year, will save more than 8,000 lives a year with new air quality standards cutting sulphur in fuel by 98%, particulate matter by 85% and nitrogen oxide emissions by 80%.

The EU plans only two low-emission marine zones which should come into force in the English Channel and Baltic Sea after 2015. However, both are less stringent than the proposed US zone, and neither seeks to limit deadly particulate emissions.

Shipping emissions have escalated in the past 15 years as China has emerged as the world's manufacturing capital. Ship pollution affects the health of communities in coastal and inland regions around the world, yet pollution from ships remains one of the least regulated parts of our global transportation system.

Shipping is responsible for 3.5% to 4% of all climate change emissions.

Ocean-going vessels are one of the largest mobile sources of air pollution in the world, powered by engines comparable in size to those that run power plants. Yet, regulation of these ships has lagged far behind other sources of air pollution.

2.12 Mitigations in Applying the Antipollution Legal Measures

For decades, the IMO has rebuffed calls to clean up ship pollution. As a result, while it has long since been illegal to belch black sulphur-laden smoke from power-station chimneys or lorry exhausts, shipping has kept its license to pollute.

For many years, the IMO has operated a policy agreed by the 169 governments that make up the organization which allows most ships to burn bunker fuel.

Bunker fuel is also thick with sulphur. IMO rules allow ships to burn fuel containing up to 4.5 per cent sulphur. That is 4,500 times more than is allowed in car fuel in the European Union.

Thanks to the IMO’s rules, the largest ships can each emit as much as 5,000 tons of sulphur in a year – the same as 50million typical cars, each emitting an average of 100 grams of sulphur a year. With an estimated 800million cars driving around the planet, that means 16 super-ships can emit as much sulphur as the world fleet of cars.

Recently, the IMO belatedly decided to clean up its act. It said shipping fuel should not contain more than 3.5 per cent sulphur by 2012 and eventually must come down to 0.5 percent.

It should not be hard to do. There is no reason ship engines cannot run on clean fuel, like cars. But, away from a handful of low-sulphur zones, including the English Channel and North Sea, the IMO gave shipping lines a staggering 12 years to make the switch. And, even then, it will depend on a final 'feasibility review' in 2018.

Smoke and sulphur are not the only threats from ships' funnels. Every year they are also belching out almost one billion tons of carbon dioxide. Ships are as big a contributor to global warming as aircraft – but have had much less attention from environmentalists.

Two-thirds of the world's ships are registered in developing countries such as Panama. These are just flags of convenience, to evade tougher rules on safety and pay for sailors. But at the IMO, governments successfully argued that ships from developing countries should not have to cut carbon emissions. Although IMO promises to heavily and consistently engage in the fight of protecting and preserving the environment, carbon emissions from shipping could triple by 2050.

Burning low-sulphur fuel won't cut carbon emissions from ships. But there are other ways. More efficient engines could reduce emissions by 30 per cent. Cutting speed could reduce emissions by as much again. And there are even wackier ways, such as putting up giant kites to harness the wind as in the days of sailing ships.

As international accords and governmental actions have placed an increasing burden upon ship owners and operators to improve vessel safety and operations to preserve the environment, there has grown an increasing resentment toward the "environmentalists". It is often claimed, and can be seen to be true in many cases, that environmental proposals simply are not in tune with the realities of the global demand for maritime transport. An "environmentalist's" response to the great concern over significantly greater needs for the transport of oil by 2025 might well be that consumers must simply be educated that they must do without increased supplies of oil. An "environmentalist's" understanding of the "polluter pays principle" has often been interpreted to mean that the vessel carrying the oil that might be spilled is the potential polluter. Remedies to make sure that this polluting shipowner pays have been many. There are regulations in place to make the shipowner pay for programs for prevention and other regulations to make sure that the shipowner pays compensation for any environmental damage that might be sustained as a result of a vessel accident. But, this "failure" of the "environmentalist" to understand the perspective of the shipowner is only half of the problem. It is often true that the ship owner, the port operator, even the government regulators do not understand the importance of the "environmentalist's" message.

By 2025, hundreds of thousands of industries will be moving industrial goods through thousands of maritime transport facilities in an attempt to reach roughly 8,200 million people. In 2025, each isolated local pollution incident will have a global significance.

Environmentalists and maritime transport professionals must all find a better understating of the environmental and developmental aspects of maritime transport. The application of the "polluter pays principle" must be clearly understood and the mechanisms to make the polluter pay must in fact work towards sustainable development and not against it. It must be understood by all parties that the polluter is really the consumer; and, if the costs of dealing with the risks of pollution and the results of the pollution are borne by the consumer then there is hope for sustainable development in the maritime transport field. It is an economic pressure that brings damage and risk of damage to the marine environment from the maritime transport system. This economic pressure is generated by the consumer. Pollution and risks of pollution will continue until they are economically unacceptable to the consumer. As systems and programs are designed to reduce the threat of pollution from maritime transport, they can be expected to

develop in comprehensiveness in proportion to the reality of the individual environmental threat. Costs of these systems and programs will likely be proportional to their comprehensiveness. If the developmental need for the environmentally harmful product or service is great enough, the consumer/polluter will be willing to bear this expense. If the need is not great enough, the costs of the environmental protective mechanisms will diminish the demand for the product or service.

As mechanisms are developed to address the environmental risk of the product or service, their potential for effectives must be measured against their ability to bring this economic pressure upon the consumer. If a regulatory mechanism directs the expense of a program or system at shipowners, the effectiveness may be defeated or minimized if some shipowners, under the pressure of competition, can find ways to "legitimately" or practically, avoid the mechanism. The shipper of the product will likely choose the ship owner who has found this less costly way of operating. The consumer will be able to avoid the cost of environmental protection by choosing the shipper that uses the ship owner that avoids the mechanism. If instead the regulatory mechanisms could be directed at all shippers who pass all costs along to consumers, the ship owners would not be seeking ways to avoid such costs and the consumer would receive the full economic pressure arising from the environmental risks of the product or service.

Most providers of transport services will not object to adopting environmental principles or regulated environmental standards, providing that these will be applied equally to all competitors and do not aggravate some natural disadvantage. If this can be done, competitive standing of an individual entity is not compromised; the cost of the environmental measure is merely passed on the customer. This is the necessary result if sustainable development is to be achieved. It is the customer, the user of the products or services, that should be expected to incur the cost of protecting the environment from that product or service. Without this, alternative products or services that are less threatening to the environment cannot compete with or replace existing products or services. This approach, to have the consumer bear the cost of protecting the environment, goes to heart of the "polluter pays principle".

From the aspect of the new or small businesses that are trying to find a way to increase market share against large or strong competitors, better product or service must be provided at lower cost. Too often today, a lower cost alternative is found by limiting or avoiding compliance with environmental principles or regulations. It is in this sector that regulation and enforcement will remain a necessary ingredient to achieve sustainable development.

However, the task of enforcement can be diminished if innovative and comprehensive approaches to government regulation are adopted.

A regulation that says that a vessel must discharge accumulated oily bilge waste to a shore based reception facility is simply not effective if no reception facility exists. The regulation must contain the solution to the problem of providing the facility. Perhaps movement of cargo by any waterborne mode must include a volumetric or tonnage tax that can be drawn upon to provide the needed facilities. The regulation is still not effective if it costs the vessel to discharge at the facility. A competitive edge can be gained if the waste can be successfully discharged at sea. The vessel must gain a competitive edge, or at least retain its competitive standing, by using the facility. Perhaps the vessel must be paid to use the facility - or can only recover a "pollution bond" if it can be shown that the facility is utilized on each port call.

Careful thought and planning on the part of all the entities in maritime transport is needed if the coming demand for increased transport capacity is to be met in a manner that

supports sustainable development principles. Awareness of the problems and acceptance of the need for sustainable development of the global transport system form the basis for success. New and aggressive thinking can provide the right approaches. Coordination and cooperation among the diverse entities involved can bring together the sound principles of local actions into a comprehensive program of global effectives.

With maritime transport systems being developed in a fashion that requires co-operation between private entities, and in concert with the support and co-operation of governments, the basis already exists for finding solutions to the many and varied environmental problems that stand in the way of sustainable development.

3. CONCLUSIONS

Can antipollution measures achieve their goal?

We can identify some of the difficulties that make legal measures ineffective in achieving their goal, respectively to efficiently stop damaging the environment:

- They are difficult to be adopted
- Their efficiency in diminishing the pollution doesn't match the amount of development
- They are easily to be avoided by shipping companies
- They can eventually try to prevent pollution incidents, but not stop pollution to occur.

As for the companies, those who are the most profitable and therefore the most polluting companies, they can afford to pay the environmental costs from their profits, continuing to pollute the environment.

If the big companies don't want to comply with the regulations, the governments have little power to enforce them, as the money from these companies is feeding the governments' budget.

As we know, huge oil spill disasters happened while the legal measures were in force and the penalties applied simply move the money from an account to another, while the environment remains greatly affected.

Conclusions should state concisely the most important propositions of the paper as well as the author's views of the practical implications of the results

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