Evaluating the use of alternative maritime power in Taiwan

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Abstract

Purpose – The purpose of this study is to empirically evaluate the impacts of institutional pressures on the use of alternative maritime power (AMP) and which in turn enhance environmental performance in the maritime shipping context.

Design/methodology/approach – Factor analysis was used to identify the key coercive pressure, normative pressure, mimetic pressure, AMP practice and green performance dimensions. The author collects data from a survey of 184 maritime shipping operators in Taiwan and applies a structural equation modelling (SEM) to test the research hypotheses.

Findings – The findings show that AMP practice act as mediator variables between institutional pressures and environmental performance.

Originality/value – Theoretical contributions and managerial implications are drawn to help maritime shipping operators to improve environmental performance.

Keywords Environmental performance, Institutional pressures, Alternative maritime power, Maritime shipping

Paper type Research paper

1. Introduction

Although ship transport is widely acknowledged as the most eco-efficient mode in terms of emissions per cargo tonnage transported (Song, 2014) to meet the globalization of business and increases in trade volume, cargo size and number of ships, the rapid growth in the maritime sector has raised serious concerns about its environmental impacts, i.e. hazardous/harmful/toxic materials, noise pollution, greenhouse gases (GHGs), waste and demand on energy (Yang *et al.*, 2013). The main pollutants emitted by ships engine combustion are GHGs, nitrogen oxides (NO_x), sulfur oxides (SO_x), carbon monoxide (CO), particulate matter (PM) and diesel particulate matter (DPM) (Eyring *et al.*, 2005), because of over 95 per cent of the world's shipping fleet is diesel engine powered (Tseng and Pilcher, 2015), high sulfur content of marine bunkers, and low quality marine fuels due to the high temperatures and pressures inside internal combustion engines (Kotrikla *et al.*, 2016). The regulations for the prevention of air pollution from ships under the international framework of Annex VI MARPOL 73/78 and at European level according to the provisions of Directive 2012/33/EU (Dragović *et al.*, 2015) are global regimes that clearly addresses the control of air emissions from ships (Tichavska and Tovar, 2015).

Ships still need auxiliary engine provide electricity to some basic functional activities (i.e. lighting, chilling, refrigeration, cooling, heating, pumps, fans, emergency

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equipment, and elevators) when docked at berth (Tseng and Pilcher, 2015). Because of the proximity of harbors to dense urban populations, in-port ship exhaust pollutants affect human beings directly and then could indirectly affect human population, built environment of many urbanized ports (Giercke, 2003; Saxe and Larsen, 2004; Tzannatos, 2010; Ng and Song, 2010; Acciaro, 2014) and coastal regions in Europe, Asia and North America, which have dense seaports and busy shipping activities (Dore *et al.*, 2007). Most importantly, however, harmful ship emissions into the air have been addressed as a risk factor for cardiovascular, respiratory conditions or even human death (Corbett *et al.*, 2007). Air pollution can cause many health problems including lung cancer, cardiovascular disease and birth defects. Ships contribute to these problems; Corbett *et al.* (2007) estimated that about 60,000 annual cardiopulmonary and lung cancer deaths along the European, East Asian and South Asian coastlines are due to PM emissions from marine vessels (Chang and Wang, 2012).

The need to control air pollution at ports is widely acknowledged as an active policy issue by various authoritative port associations (Tzannatos, 2010; IAPH, 2007; ESPO, 2007). New and upcoming regulations aim to decrease emissions from shipping, and, coupled with increased environmental consciousness of ship owners and harbor operators, shore supply is becoming a more popular and feasible option (Sciberras *et al.*, 2015). Alternative maritime power (AMP)/cold-ironing technology approach allows vessels at berth to use shore power rather than rely on electricity generated by their auxiliary engines, thus reducing exhaust NOx, SOx and PM emissions in ports which are viewed as useful strategies (Chang and Wang, 2012; Kim *et al.*, 2012; Lam and Notteboom, 2014; Tseng and Pilcher, 2015; Sciberras *et al.*, 2015; Ballini and Bozzo, 2015).

In this study, I argue about the reasons why shipping companies and port corporations adopt AMP/shore power dependent on the institutional pressures that are exerted on them by public organizations and competitors in shipping industry. However, to date, no research has empirically investigated the effects of institutional pressures on AMP practice and its consequence of environmental performance improvement. This study will help determine whether adopting these AMP practice is worth the effort of these organizations in terms of environmental performance. It will also help us identify what relationships seem to be significant, providing guidance to shipping liners and port corporations in what AMP practice may be worthwhile to adopt.

The research framework, shown in Figure 1, is developed to investigate the relationships between three institutional pressures (i.e. coercive, normative and mimetic pressure), AMP practice and environmental performance of shipping liners and port

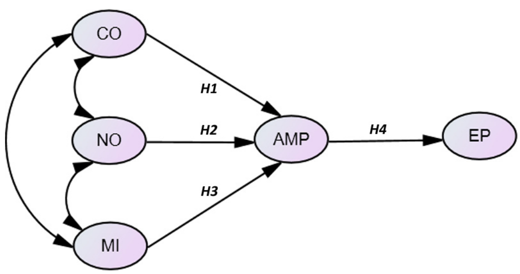


Figure 1. The conceptual model

corporations. There are six sections in this paper. Following this introduction, the next section is a review of previous research on institutional pressures, AMP and environmental performance. Four research hypotheses are postulated. Section 3 discusses the research methodology, including measures of the survey, sampling techniques and research methods. Section 4 presents the analytical results of descriptive statistics, confirmatory factor analysis (CFA) and structural equation modeling (SEM). Section 5 presents conclusions drawn from the research findings and the implications are discussed, and limitations and further research suggestions are presented in the final section.

2. Theoretical background and hypotheses

2.1 Institutional pressures

Institutional theory argues that firms embedded in social networks perceive strong pressure to conform to institutional expectations and norms for appropriate organizational structures, operations and practices (DiMaggio and Powell, 1983; Zucker, 1987; Scott and Christensen, 1995) to acquire social legitimacy and access to important and rare resources because violations may jeopardize organizational performance (Scott, 2001) and long-term development. DiMaggio and Powell (1983) argue that managerial decisions are strongly influenced by three institutional mechanisms – coercive, normative and mimetic isomorphism – that emphasize the role of pressures exerted by international and national government agencies, professional organizations and social expectations, respectively, to produce similar practices and structures.

A firm's enrollment in a voluntary environmental initiative is driven not only by financial considerations but also by the need to attain socially constructed environmental legitimacy (Rivera, 2004). Several studies (Jennings and Zandbergen, 1995; Rugman and Verbeke, 1998; Majumdar and Marcus, 2001; Delmas and Toffel, 2004) have applied institutional theory on the field of firms' environmental management practices. In this study, through the lens of institutional pressures from international organizations (i.e. United Nations [UN], European Union [EU], International Maritime Organization [IMO]) that impose conventions/directives/regulations on shipping operations and rival organizations that compete for businesses, I provide the reasons why shipping companies and port corporations that adopt AMP depend on coercive/normative pressures from international organizations and mimetic pressure that are exerted on them by competitors.

2.1.1 Coercive pressure. Coercive pressure, usually imposed by binding international organizations and national governments, require the company to comply with the relevant regulations and pursue specific behaviors by relying on legal sanctions or threats (Meyer and Rowan, 1977). Government regulations or the threat of penalties can provide clear standards of behavior for firms, as well as force the adoption of practices by firms (Simpson, 2012). Failing to respond to these regulations engenders significant risk to a firm's legitimacy and viability. Regulations are generally considered to be the greatest source of external influence on a firm's activities (Lai and Wong, 2012) and coercive pressure is usually an important factor that drives environmental management practices. With increasing consciousness of environmental protection, UN, EU, and IMO have established many environmental conventions/directives/regulations, which exert coercive pressure on shipping-related companies, and managers typically interpret it as the most obvious pressure to organizations' environmental initiatives (Zhu and Sarkis, 2007). Organizations should comply with these environmental conventions/directives and regulation, otherwise they will face the threat of government levying legal actions, penalties, or even worst, removal from the market (Sarkis *et al.*, 2010). Base on the discussion in this section, this study, therefore, proposes the following hypothesis:

H1. Coercive pressure is positively associated with alternative maritime power practice.

2.1.2 Normative pressure. Institutional power over of an organization can be regulative (e.g. government regulations, contracts or the threat of penalty), as well as more normative, in the form of peer practices, and industry standards (Scott and Christensen, 1995) often have less power to penalize firms for non-compliance (Simpson, 2012). The normative pillar of the institutional environment refers to sets of expectations, within particular organizational contexts, of what constitutes appropriate and legitimate behavior (Scott and Christensen, 1995). Normative pressures arise from values and norms of conduct promoted by professional networks, industry associations and academic institutions (Hoffman, 1999). These expectations are transferred and gradually become shared norms which influence firm attitudes toward the maintenance of relationship networks (Heide and John, 1992) and put the firm in a position to assure constituents in the field that it maintains procedural legitimacy (Zsidisin *et al.*, 2005). The desire to improve or maintain of cooperative relationships, maritime shipping companies and port corporations conform to normative pressure and the implementation of AMP practices. Previous researches have also found that members of associations face stronger normative pressure to get involved in voluntary environmental initiatives and then enhance environmental performance (Delmas, 2002; Garcia-Johnson, 2000; King and Lenox, 2000). Base on the discussion in this section, this study, therefore, proposes the following hypothesis:

H2. Normative pressure is positively associated with alternative maritime power practice.

2.1.3 Mimetic pressure. Mimetic pressures occur when an organization imitates the actions of successful competitors in the industry in an attempt to duplicate their success. Such action is typically defined as competitive benchmarking. The performance of these successful companies, which are considered as leaders in their sector, forces other companies in the same sector to become like them, as they face the same environmental conditions (DiMaggio and Powell, 1991). Firms may not only imitate organizations they perceive as successful in their industry but also imitate organizations with which they have social ties (Galaskiewicz and Wasserman, 1989). The rationale is simply to follow actions of successful competitors to repeat their successful path (Christmann and Taylor, 2001). In particular, the firm will ascribe its competitors' success to their strategic choices and imitate these successful firms by adopting the same practices (John *et al.*, 2001; Zsidisin *et al.*, 2005). Good practice pervades because of competitive pressure. If main competitors have adopted green strategy are perceived favorably by customers, considered a competitive differentiator, benefited greatly and gain comparative competitive advantages, other companies will also adopted environmental practices. Effective environmental shipping practices have become important point of difference and opportunity to reduce pollutants, attract shippers and build corporate green image. Firms may mimic the environmental practices that successful leading firms have adopted. Base on the discussion in this section, this study, therefore, proposes the following hypothesis:

H3. Mimetic pressure is positively associated with alternative maritime power practice.

2.2 Alternative maritime power

Ship service electrical power consumption at the shore side has rapidly grown for commercial ships (Peterson *et al.*, 2007), as the EU Sulphur Directive limits the sulphur content of fuels used by ships in EU ports to less than 0.1 per cent by mass when the scheduled stay is longer than 2 h and shuts down all engines to use a shore electrical supply are considered compliant and then reduce air pollutions generated at berth (Sciberras *et al.*, 2015). Shore power or AMP is the provisions for land-to-ship power supply systems that allow ships to plug in to the shore electrical network and switch off onboard diesel-powered generators while docked (Ballini and Bozzo, 2015). AMP entails three basic components: a shore-side electrical system and infrastructure, a cable management system and a ship-side electrical system (Tseng and Pilcher, 2015). It helps to reduce emissions while ships at berth, improve air quality, reduce noise and vibrations in port areas (Yang *et al.*, 2011). This study defines AMP practice as the company devoted to providing AMP-related workers, and employees an experience with education for knowledge enhancement, AMP operational training and high-quality collaboration with partners (i.e. suppliers and customers) between those conducting AMP implementation. Shore-side electricity supply can effectively reduce hazardous emissions (e.g. SOx, NOx, DPM, PM) in the local environment significantly (Chang and Wang, 2012; Ballini and Bozzo, 2015), increase sustainability and reduce the environmental impact of shipping activities at berth (Theodoros, 2012; Zis *et al.*, 2014; Tseng and Pilcher, 2015) and improve the socioeconomic conditions for workers and for those living in and around the port area (Tseng and Pilcher, 2015). Base on the discussion in this section, this study, therefore, proposes the following hypothesis:

H4. AMP practice is positively associated with environmental performance.

2.3 Environmental performance

Environmental performance refers to the measurement of the interaction between the business and the environment (Olsthoorn *et al.*, 2001). Environmental performance can be measured in terms of various indexes that include the reduction in consumption of energy, environmental pollutions, wastes, waste water emissions and air pollutant emissions in the shipping industry. Zhu and Sarkis (2004) proposed that enterprises having higher levels of adoption of green practices will have better environmental performance improvements. AMP practices can effectively reduce hazardous emissions (e.g. air pollutant emissions: SOx, NOx, PM and DPM), thus enhance environmental performance in the local environment (Ballini and Bozzo, 2015; Chang and Wang, 2012).

3. Methodology

3.1 Sample

Evergreen Marine Corporation, Yang Ming Marine Transport Corporation, China Steel Express Corporation, Port of Keelung (Taiwan International Ports Corporation) and Port of Kaohsiung (Taiwan International Ports Corporation) in Taiwan were used as survey source for this study because they are currently using the AMP system. This study identified key interviewees, including president, vice/president and senior managers who are knowledgeable about the company's institutional pressures, AMP practices and environmental performance. The survey was administered by mail with a postage-paid return envelope sent to 300 AMP-related managers/workers/employees, and they were contacted by telephone to identify their willingness to participate in the survey. The initial mailing elicited 112 usable responses. A follow-up mailing was sent six weeks after the initial mailing. An additional 72 usable responses were returned. Therefore, the total usable number of responses number is 184, which gives an overall response rate of 61.3 per cent. Although the total response rate reached 61.3 per cent, it is important to deal with the potential problem of non-response bias. A comparison of early (those responding to the first mailing) and late (those responding to the second mailing) respondents recommended by Armstrong and Overton (1997) was carried out in this study to test for non-response bias by *t*-tests analysis. The *t*-tests were performed on the two groups' perceptions of the agreement of the various institutional pressures, AMP practices and environmental performance. There were no significant differences between the two groups' perceptions of the agreement of the various items at the 5 per cent significance level. Results, therefore, suggested that non-response bias was not a problem since late respondents' responses appeared to reflect those of first group respondents.

3.2 Measures

I undertook an extensive study of the literature to identify extant measures for related constructs. The measures for coercive, normative and mimetic pressures were adapted from Chan *et al.* (2015), Zhu and Sarkis (2006), Zhu *et al.* (2013), Vachon and Klassen (2006), Ye *et al.* (2013), Liu *et al.* (2010). The measures for AMP practices were adapted from Laari *et al.* (2016), Govindan *et al.* (2015), Chang and Wang (2012). The measures for environmental performance were selected from those used by Yang *et al.* (2013), Chang and Wang (2012), McKinley *et al.* (2005). I developed and refined all of the scales according to the input from interview with experienced shipping practitioners comprising captains, vice president and managers. Interviews resulted in minor modifications to the wording of and examples provided in some measurement items. These items were scored using a five-point Likert scale, where 1 corresponds to "strongly disagree" and 5 to "strongly agree". In addition, I validated the resulting scales with field pilot tests to ascertain their content validity, as well as construct reliability and validity. The questionnaire was pilot tested in a sample of 15 managers. Based on their feedback, I modified, added or deleted questions making them more understandable and relevant to practices. Appendix 1 presents the final measurement items employed for evaluating institutional pressures, AMP practices, and environmental performance.

3.3 Data analysis methods

First, descriptive statistics, exploratory factor analysis and item total correlation analysis were used to summarize the large number of institutional pressures, AMP practice and environmental performance attributes into smaller, manageable sets of underlying factors or dimensions. A two-step approach suggested by Anderson and Gerbing (1988) was used to analyze the data. In the first step, CFA was used to examine the convergent validity, discriminant validity and construct reliability of coercive pressure, normative pressure, mimetic pressure, AMP practices and environmental performance. Once it is validated, the second step requires estimating the structural model from the latent variables. A SEM approach was subsequently used to test the research hypotheses. This technique can handle a large number of endogenous and exogenous variables, as well as latent (unobserved) variables specified as linear combinations (weighted averages) of the observed variables (Golob, 2003). All analyses were carried out using the *SPSS 18.0 for Windows* and *AMOS 18.0* statistical packages.

4. Results of empirical analyses

4.1 Participants' demographics

The profiles of respondents' companies and their characteristics are displayed in Table I. Results reveal that questionnaire survey respondents were senior managers or above (26.6 per cent), managers/directors (38.6 per cent) and workers/employees (34.8 per cent). Results reveal that questionnaire survey respondents were from operation department (12.0 per cent), management department (43.5 per cent), engineer department (27.7 per cent) and safety/security (16.8 per cent). Table I reveals that almost 80 per cent of respondents have worked in the shipping industry for more than 10 years. The finding implies that respondents have abundant practical experience to answer the questions. Results presented in Table I indicate that 46.7 per cent of respondents are from shipping company, and 53.3 per cent of respondents are from port corporations.

Table I. Profile of respondents (n = 184)

Characteristics of respondents	Frequency	(%)
Type		
Shipping company	86	46.7
Port corporation	98	53.3
Job title		
Senior managers or above	49	26.6
Managers/directors	71	38.6
Workers/employees	64	34.8
Department		
Operations	28	12.0
Management	80	43.5
Engineer	51	27.7
Safety/security	31	16.8
Seniority		
Less than 5 years	33	17.9
6-10 years	9	4.9
11-15 years	76	41.3
16-20 years	13	7.1
21 years or more	53	28.8
Number of employees		
Less than 500	92	50.0
501-2000	46	25.0
2001 or more	46	25.0

4.2 Exploratory factor analysis results

Factor analysis was used to reduce the institutional pressure attributes, AMP practices, and environmental performance attributes to smaller, manageable set of underlying factors (dimensions). This helped to detect the presence of meaningful patterns among the original variables and extract the main factors. Principal component analysis with VARIMAX rotation was employed to identify the dimensions of coercive pressure, normative pressure, mimetic pressure, AMP practice and environmental performance. The results of factor analysis for these dimensions are indicated in Appendix 1 yielded factors or dimensions with eigenvalues greater than one (Churchill and Iacobucci, 2002). According to Hair *et al.* (2006), factor loadings of 0.50 or greater are considered practically significant. The larger the absolute size of the factor loading, the more important the loading is in interpreting the factor matrix. Results revealed that measurement items all had strong loading on the construct. The generally agreed lower limit for Cronbach's alpha is 0.60 (Flynn *et al.*, 1990; Nunnaly, 1994). Cronbach's alpha values in Appendix 1 indicate that all constructs are reliable for this research. Based on the Cronbach's alpha values, I conclude that the scales are reliable. Appendix 1 also shows respondents' agreement levels with each dimension in the current situation. The results indicate they considered the environmental performance dimension (mean = 3.89) the highest agreement level, followed by coercive pressure dimension (mean = 3.85), normative pressure dimension (mean = 3.78), and mimetic pressure dimension is the lowest agreement level (mean = 3.21).

4.3 Confirmatory factor analysis

The CFA factor loadings are shown in Table II. The average variance extracted (AVE) values for all constructs are higher than 0.50. CFA, using *AMOS 18.0* software, was conducted to further examine uni-dimensionality of measurement items. The results revealed a good fit according to model fit indices of χ^2/df = 1.858 [the acceptable ratio is less than 2.0 (Tabachnick and Fidell, 2007)], GFI = 0.904, AGFI = 0.855, CFI = 0.976 [the CFI was superior to other indices for small samples, and a value exceeding 0.90 indicated a reasonably good fit of the research model (Hu and Bentler, 1999)], IFI = 0.976 [the IFI exceeded the common standard of 0.9 (Hair *et al.*, 2006)], RMR = 0.023 [a value of 0.05 or less indicated an acceptable model (Byrne, 1998)] and RMSEA = 0.069 [a value less than 0.08 is generally considered a good fit (Hu and Bentler, 1999)]. This indicates that the model is acceptable and uni-dimensionality and reliability were further confirmed. Next, discriminant validity and convergent validity were tested. Discriminant validity is the degree to which measures of different latent variables are unique, whereas convergent validity relates to the degree to which multiple methods of measuring a variable provide the same results (O'Leary-Kelly and Vokurka, 1998). CFA is used in the study to ascertain convergent and discriminant validity. Convergent validity can be tested by *t*-values that are all statistically significant on the factor loadings (Dunn *et al.*, 1994). For this model, all the factor loadings are greater than 0.50, and all *t*-values are greater than 1.96. Therefore, convergent validity is achieved. Discriminant validity was assessed to provide evidence that the constructs in this study are unique and that each captures some phenomena that other measures do not (Hair *et al.*, 2006). The approach used holds that the AVE value of each construct should be higher than the squared correlation (also known as shared variance) of that construct

Latent variables	Unstandardized factor loading	Completely standardized factor loading	SE[a]	CR[b]
ξ1: Coercive pressure (AVE: 0.700)				
CO1	1.000	0.957	–[c]	–
CO2	0.985	0.927	0.050	19.707
CO3	0.637	0.571	0.073	8.747
ξ2: Normative pressure (AVE: 0.851)				
NO1	1.000	0.953	–[c]	–
NO2	0.993	0.940	0.040	25.018
NO3	0.926	0.872	0.047	19.807
ξ3: Mimetic pressure (AVE: 0.832)				
MI1	1.000	0.924	–[c]	–
MI2	1.015	0.911	0.051	20.058
MI3	1.051	0.902	0.054	19.582
ξ4: AMP practices (AVE: 0.785)				
AMP1	1.000	0.932	–[c]	–
AMP2	1.040	0.897	0.069	15.039
AMP3	1.101	0.825	0.070	15.751
ξ5: Environmental performance (AVE: 0.928)				
EP1	1.000	0.942	–[c]	–
EP2	1.025	0.974	0.033	30.831
EP3	1.045	0.973	0.034	30.650

Notes: [a]SE is an estimate of the standard error of the covariance; [b]CR is the critical ratio obtained by dividing the estimate of the covariance by its standard error. A value exceeding 1.96 represents a level of significance of 0.05; [c]indicates a parameter fixed at 1.0 in the original solution; fit indices: χ^2/df = 1.858, GFI = 0.904, AGFI = 0.855, CFI = 0.976, NFI = 0.949, IFI = 0.976, RMR = 0.023, RMSEA = 0.069

Table II.
Results of confirmatory factor analysis

with the others. As illustrated in Table III, all AVE values are greater than the squared correlations, indicating discriminant validity for all of the latent constructs.

4.4 Test of hypotheses

The coercive pressure, normative pressure, mimetic pressure, AMP practice and environmental performance variables are analyzed simultaneously in SEM. The results

Latent variables	ξ1	ξ2	ξ3	ξ4	ξ5
ξ1: Coercive pressure	*0.700*	0.33	0.58	0.48	0.33
ξ2: Normative pressure	0.33	*0.851*	0.49	0.50	0.34
ξ3: Mimetic pressure	0.58	0.49	*0.832*	0.49	0.44
ξ4: AMP practice	0.48	0.50	0.49	*0.785*	0.47
ξ5: Environmental performance	0.33	0.34	0.44	0.47	*0.928*

Notes: The figures italic represent AVE; figures below the AVE line are the correlations between the constructs

Table III.
Correlations and AVE

of *H1*-*H4* are shown in Table IV and Figure 2. The standardized coefficients indicate that out of the four hypotheses, *H1*, *H3* and *H4* are significant at the 0.001 level, whereas *H2* is significant at the 0.05 level. All four hypotheses are supported (as shown in Table IV). As a result, coercive pressure has a positive influence on AMP practice (*H1*, $\hat{a}_1 = 0.311$, $p < 0.001$). The normative pressure exerts a positive influence on AMP practice (*H2*, $\hat{a}_2 = 0.185$, $p < 0.05$), and mimetic pressure also is positively associated with AMP practice (*H3*, $\hat{a}_3 = 0.305$, $p < 0.001$). Finally, the AMP practice exerts a positive influence on environmental performance (*H4*, $\hat{a}_4 = 0.497$, $p < 0.001$).

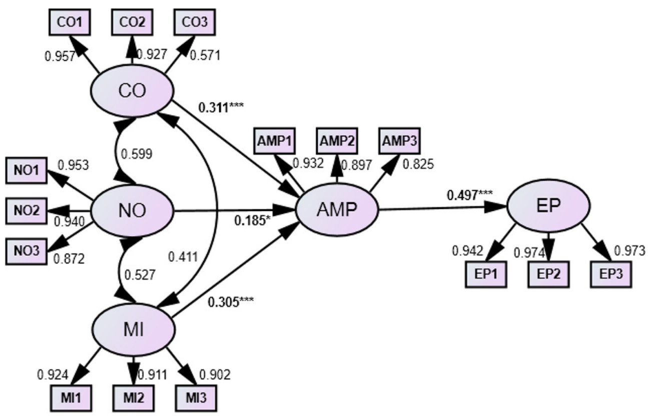
5. Conclusions and discussion

With the requirements of sustainability and the globalization of shipping operation, shipping companies and port corporations have made some progress in adoption of green technology equipment (e.g. AMP). However, AMP is still a new concept in Taiwan. Interview with practitioners show that AMP is an important trend for developing green port and green ship, and there is indeed significant reduction of air pollutant emissions from adoption and use of AMP, whereas there are a number of issues raised (e.g. the cost of equipment installation and implementation cost is high, the

Paths	Estimate ($\hat{a}$)	P	Outcome
H1: CO → AMP practice	0.311 ($\hat{a}_1$)	0.000***	Supported
H2: NO → AMP practice	0.185 ($\hat{a}_2$)	0.033*	Supported
H3: MI → AMP practice	0.305 ($\hat{a}_3$)	0.000***	Supported
H4: AMP practice → EP	0.497 ($\hat{a}_4$)	0.000***	Supported

Notes: *Correlation is significant at the 0.05 level, ***correlation is significant at the 0.001 level

Table IV. Results (standardized) of hypotheses tests using SEM



Notes: *Correlation is significant at the 0.05 level, **Correlation is significant at the 0.01 level; ***Correlation is significant at the 0.001 level; Fit indices: χ^2/df = 1.924, GFI = 0.897, AGFI = 0.852, CFI = 0.973, NFI = 0.946, IFI = 0.973, RMR = 0.039, RMSEA = 0.071

Figure 2. Estimated structural equation model

voltage types, and connection types between ship and shore is not unified). This study provides an empirical assessment of coercive pressure, normative pressure, mimetic pressure and AMP practice in the maritime shipping operation and how these variables influence their environmental performance. The findings indicate that coercive pressure (*H1*), normative pressure (*H2*) and mimetic pressure (*H3*) have positive effects on AMP practice and then, in turn, AMP practice has significantly positive effect on environmental performance (*H4*).

5.1 Implications for researchers

This study answers the call from Tseng and Pilcher (2015), urged researchers to interview key participants, where AMP has been introduced to gather their experiences on how this was done, it would be one fruitful area of future research. Although several previous studies have evaluated institutional pressure in strategy and organizational behavior for some time, the application of institutional theory in AMP for improving environmental performance of maritime shipping companies and port corporations is rather limited. First, from a research point of view, the results support the relevance of the institutional pressures as a driver of environmental performance. Theoretically, this study highlights the importance of institutional pressures and AMP practice in explaining the environmental performance. Second, AMP practice mediates the impact of institutional pressure on environmental performance. The findings suggest that there are indeed institutional pressures that influence AMP practice, which further enhance environmental performance. This study extends this body of literature on shipping management by empirically highlighting that the mediating effect of AMP practice on the relationship between institutional pressures and environmental performance in the context of maritime shipping. Third, the normative pressure, as an ethical/moral code of conduct of company, is not legally enforceable, and its impact on AMP practice is much weaker than coercive pressure and mimetic pressure. Normative factor and ethical behavior are important factors influencing employee ethical behaviors that must be taken into consideration by shipping companies and port corporations (Lu and Lin, 2014). I believe that framing the role of normative pressure in future research is a contribution to the environmental management literature that will aid future theoretical development in the shipping industry.

5.2 Implications for managers

The findings of this study provide the empirical evidence to support that institutional pressures enable shipping liners and port corporations to implement AMP practices and that environmental performance improvements derived. This result also points to the need for maritime shipping companies and port corporations to become better endeavored in devoting of AMP practices (i.e. AMP knowledge enhancement, AMP operational training and AMP collaboration with partners). From the empirical evidence, coercive pressure is the most effective enabler for AMP practice, followed by mimetic pressure, whereas normative pressure is the lowest one. Therefore, environmental conventions/directives of UN, EU and IMO are the strongest foundation for effective AMP implementation. Overall, the results highlight the importance for understanding the influential paths of institutional pressures on AMP practice is critical for maritime shipping companies and port corporations to strategically arrange their resource on AMP installation and operation to maintain their social legitimacy and contribute to environmental protection. Coercive pressure of international conventions/directives and mimetic pressure of competitors' green strategy are main enablers of AMP practice. This reveals that it is necessary for shipping liners and port corporations to align resources and activities to cope with. Furthermore, the pressure of environmental conventions/directives was actually originated from public international organizations (i.e. UN, EU and IMO). Policy makers and manufacturing companies should take the AMP high cost, inconsistent voltage and frequency, inconsistent connection types between ship and shore and technological improvements into consideration.

6. Limitations and future research

While the objectives of the study are accomplished, several limitations of the present study should be noted. First, in this study, the data collection was restricted to maritime shipping companies and port corporations in Taiwan. A different sample could be employed from different countries to verify the findings. Second, another worthwhile direction for future research might be the use of the strategic group concept to classify shipping companies and port corporations into different pressures-oriented firms based on the aforementioned coercive, normative and mimetic pressure dimensions. Such an approach might investigate environmental performance differences among various strategic groups. Third, the results in this study do not imply that this is the only valid AMP model for the enhancement of environmental performance of shipping companies and port corporations, although the model provide a good fit to the data. Finally, this study was limited to environmental performance dimension, although environmental performance is important and explained by AMP implementation. Future studies should seek to consider other variables such as economic performance, social performance or healthy performance. These variables may be impacted by AMP practice and institutional pressures examined in the present study, and may provide further insight on the results discussed above.

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Appendix

Measurements	loading
Coercive pressure (Mean = 3.85, SD = 0.64, Cronbach's α = 0.85, CITC range = 0.56-0.81) Prior studies: Zhu and Sarkis (2006); Zhu et al. (2013); Chan et al. *(2015)*	
CO1. UN environmental conventions/directives	0.747
CO2. EU environmental conventions/directives	0.781
CO3. IMO environmental conventions/directives	0.700
Normative pressure (Mean = 3.78, SD = 0.69, Cronbach's α = 0.94 , CITC range = 0.85-0.91) Prior studies: Zhu et al. (2013), Vachon and Klassen (2006), Ye et al. *(2013)*	
NO1. International association of ports and harbors (IAPH) environmental initiative	0.764
NO2. The Association of Pacific Ports (APP) environmental initiative	0.752
NO3. European Sea Ports Organization (ESPO) environmental initiative	0.743
Mimetic pressure (Mean = 3.21, SD = 0.81, Cronbach's α = 0.94, CITC range = 0.87-0.88) Prior studies: Zhu et al. (2013), Zhu and Sarkis (2006), Liu et al. *(2010)*	
MI1. Our main competitors have adopted green strategy	0.848
MI2. AMP is considered a competitive differentiator in my company	0.891
MI3. Our main competitors that have adopted AMP are benefited	0.881
AMP practice (Mean = 3.38, SD = 0.80, Cronbach's α = 0.91, CITC range = 0.78-0.86) Prior studies: Laari et al. (2016), Govindan et al. *(2015), Chang and Wang (2012)*	
AMP1. My company devoted to AMP knowledge enhancement	0.822
AMP2. My company devoted to AMP operational training	0.825
AMP3. My company devoted to AMP collaboration with partners (suppliers and customers.)	0.778
Environmental performance (Mean = 3.89, SD = 0.74, Cronbach's α = 0.97 , CITC range = 0.93-0.95) Prior studies: Yang et al. (2013), Chang and Wang (2012), McKinley et al. *(2005)*	
EP1. Air pollutant emissions: Particulate Matter (PM10 and PM2.5)	0.920
EP2. Diesel Particulate Matter (DPM)	0.932
EP3. Air pollutant emissions: NOx and SOx	0.925

Table AI. Construct measurement