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Developing Green IS through translation: The case of an environmental sustainability tool

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Abstract

Green information systems (Green IS) can assist in the achievement of sustainability initiatives and enhance environmental and economic performance. The goal of this paper is to investigate the phenomena that occur when heterogeneous actors engage in complex patterns of interaction in their Green IS development efforts. Drawing on actor-network theory (ANT), we "follow the actors" participating in the development of the Vessel Management System (VMS), a sustainability tool to help enforce compliance with legislation that protects South Australia's aquatic environment. We find that focal actors with legislative powers, legitimacy, and ability to apply urgency influences can undertake effective translation of actors in emerging actor-networks. This study contributes by integrating ANT and Green IS development with the introduction of sustainability legislation in an environment protection context.

Keywords

Green IS, actor-network theory (ANT), translation, sustainability

INTRODUCTION

Green information systems (Green IS) are innovative tools that can assist in the achievement of sustainability initiatives. Defined as "IS-enabled organizational practices and processes that improve environmental and economic performance" (Melville, 2010), Green IS can be pivotal in fostering compliance with legislation, analysing sensor data, transmitting to controllers, and providing information to consumers, governments and managers in monitoring their emissions and waste, and increasing energy efficiency (Watson et al., 2010; Watson et al., 2011). Green IS can also improve sustainability performance by playing a central role in committing actors to key sustainability indicators and fostering collaboration amongst government and industry (Bengtsson and Ågerfalk, 2011). Recent research shows that developing Green IS can be highly complex due to the continuous and complicated webs of interactions that occur amongst different organisational actors that are directly or indirectly affected by these systems (Garud and Rappa, 1994; Watson et al., 2010). Channelled through networks that include regulators, standard-setting bodies, industry associations, user communities, software developers, these interactions can shape how and why Green IS are built, the social construction of their meaning, and the manner in which their properties evolve. The complexity of developing Green IS is, thus, underpinned by "cooperative, multi-actor research and development" (Lyytinen and King, 2006, p. 405) which suggests that conventional approaches to IS research may be inadequate for studying how these systems emerge (Lyytinen and King, 2006; Orlikowski and Iacono, 2001; Watson et al., 2010; Watson et al., 2011). To address this gap, we investigate the development of the Vessel Management System (VMS), a Green IS that was developed by a South Australian regulator for monitoring compliance with environment protection legislation for vessels operating in the state's inland and marine waters. Examining VMS development is interesting as many heterogeneous actors are affected by it in various ways. Thus, VMS development decisions must be shared amongst these actors which may require complex interactions and negotiations that determine the shape that the VMS will (or will not) take.

Our goal is to investigate the following research question: what phenomena occur when heterogeneous actors, such as vessel owners and operators, regulators, standard-setting bodies, industry associations, and software developers, engage in complex patterns of interaction in VMS development efforts? To achieve our goal, we employ actor-network theory (ANT). ANT can provide detailed and precise descriptions of how networks of heterogeneous actors attempting VMS development are built (Rodon et al., 2008). Therefore, this contributes a holistic approach conducive for the sustainable development of GreenIS in the future. Taking a holistic approach is important as the heterogeneous stakeholders that participate in VMS development have different internal systems and inconsistent objectives, which can make achieving VMS development outcomes difficult. Thus, it takes a community of organisations to develop the VMS (Rampersad, 2012; Rampersad et al. 2010; Schoonhoven and Romanelli, 2001). The different, or potentially incompatible interests of community actors need to be aligned (Allen, 2000) if the VMS is to "gain acceptance and establish a trajectory that can lead to wide adoption and institutionalization" (Wang and Swanson, 2008, p. 326). By examining the roles played by the focal actor in the VMS development network, we attempt to address criticism about extant ANT accounts for providing limited insights concerning the roles played by these actors in the complex collaboration dynamics of actor-networks (Lee and Oh, 2006). In pursuit of this goal, we contribute insights concerning how sustainability initiatives can be introduced, and more broadly, enhance current understanding of why and how Green IS are developed, thereby, addressing growing calls for further research in this area (Lee and Oh, 2006; Lyytinen and King, 2006; Watson et al., 2010; Watson et al., 2011; Yoo et al., 2005). To achieve our goal, after discussing VMS background, we explain ANT and the rationale for using it. Actor translation in VMS development is analysed before the paper is concluded.

BACKGROUND TO THE VMS

Regulation constitutes a common form of protecting the environment and related sustainability initiatives. For example, legislated by the South Australian Government in 1993, the Environment Protection Act, henceforth referred to as the Act, provides the regulatory framework to protect South Australia's environment, including land, air, and water (SAGovernment, 2003). The Environment Protection Authority (EPA) is one of the South Australian regulators that aims at administering the Act through legal instruments, including policy, regulation, and codes of practice, to address environmental issues (EPA, 2011). To help combat the pollution of marine and inland waters and improve water quality, the EPA introduced the Code of Practice for Vessel and Facility Management, henceforth referred to as the CoP (Ballantine, 2008). The CoP is meant to facilitate the fulfillment of obligations under the Act, including related policies. However, before it can become enforceable, a CoP must consider industry idiosyncrasies in formulating "reasonable and practical outcomes and recommended practices" (Ballantine, 2008, p. 5) after extensive consultation with all actors likely to be affected by it, and endorsement from the state government. As the CoP is linked with policies under the Act, compliance to its requirements is legally enforceable whilst non-compliance constitutes a breach of, and is, thus, an offence under the Act (Ballantine, 2008).

Whilst the CoP is outlined as 'musts' and 'shoulds', its enforcement in practice entails extensive data collection, report generation, and communication with actors pertaining to CoP compliance monitoring and enforcement. With the need to regulate over 50,000 vessels currently operating in South Australia's marine and inland waters, the amount of data to be collected was anticipated to be extremely large (SAWL, 2009; SAWL, 2009a). To address issues concerning data manageability, complexity, duplication, consistency, accuracy and loss that were anticipated to arise with conventional tools (e.g. spreadsheets), the VMS was developed with requirements fundamentally underpinned by the CoP. Specifically, the VMS aims to formalise EPA relationships and facilitate its communication with actors in order to ensure compliance with legislation, that is, the CoP, the Water Quality Environment Protection Policy (WQEPP), and the Act. For example, the VMS captures and stores data about vessels such as ownership and on-board facilities including their technical specifications and corresponding image-based evidence (e.g. photographs). It also generates formal correspondence between the government and owners and industry players as it pertains to regulation. This allows the EPA to be in possession of up-to-date information concerning vessels' compliance history and current status. With structured correspondence management and reporting features, the EPA can easily identify non-compliant actors, send out warnings, and efficiently locate correspondence history concerning underlying causes and course of action undertaken as a result. With greater awareness concerning compliance requirements and the ability to automatically generate correspondence to be sent out to vessel owners and operators, regulatory processes can become streamlined and efficient. It was, thus, hoped that a greater number of vessels would become compliant which meant that the CoP, WQEPP, and the Act would be upheld and that inland and marine waters would, thus, be better protected. This paper provides a dynamic process-oriented view of the phenomena that occur during the alignment of the interests of heterogeneous actors in the CoP and VMS functionality development whilst also accounting for ensuing outcomes and the proactive and reactive strategies of key actors.

ACTOR-NETWORK THEORY

ANT offers a framework for investigating how technical artifacts come into being (Allen, 2004; Bijker, et al. 1987; Latour, 1999; McLean and Hassard, 2004). It focuses on actors and their attempts to secure their interests by forming and strengthening alliances in actor-networks. Actors represent human or non-human entities that are able to make their presence individually felt by other actors (Callon, 1986a; MacKenzie and Wajcman, 1999). ANT provides a symmetrical treatment between the technical and the social aspects of technology (Callon, 1986a). This means that both social and technical actors are treated alike and that they are seen as "interconnected… interacting and mutually shaping each other" (MacKenzie and Wajcman, 1999, p.80). That is, technical artifacts are treated as genuine actors as they constitute a dynamic embodiment of human actors' subjectivities, including their motives, intentions, interests and prejudices (Faraj et al., 2004; Klischewski, 2002). Thus, technical artifacts encapsulate effects resulting from the interaction of collaborating and contending actors as they enrol in networks of allies or supporters. There are two pivotal concepts underpinning ANT, namely, inscription and translation. Inscription means that actors that develop an artifact seek to inscribe their interests into it. When inscribed, interests may be manifested as specific anticipations and restrictions concerning future patterns of use of the artifact (Hanseth and Monteiro, 1997; Ramiller, 2007). In fact, "[a] technology by virtue of the particulars of its design, invariably reflects the interests of some actors and not of others" (Ramiller, 2007, p. S198), and it "tells or prescribes the roles that it… expects other elements [actors] in the network to play" (Klischewski, 2002, p. 312). The artifact, thus, becomes a genuine actor that has the ability to impose inscribed interests onto other actors.

With translation a focal actor undertakes a variety of negotiations with various actors in attempts to make them allies by continually aligning their interests in a network that is dedicated to constructing a technical artifact which the focal actor is championing (Callon, 1986a; Ramiller, 2005; Rodon et al., 2008). Translation also entails convincing allies to act in accordance with the roles into which they have been cast by the focal actor, and in the process, achieve stability in the network (Ramiller, 2005). Translation comprises four stages, namely, problematization, interessement, enrolment, and mobilization. Problematization identifies a problem and it characterises the manner in which it affects the interests of various actors (Lee and Oh, 2006). It also positions a focal actor as a champion and an indispensable resource that can propose, develop or direct the development of a technical artifact as a solution to the identified problem (Ramiller, 2005). In attempts to build its network, the focal actor identifies an obligatory passage point (OPP), "a situation through which the heterogeneous actors involved … must be made to pass" (Ramiller, 2005, p.57). Getting actors to cross the OPP and join the network, requires that they become persuaded about the ways in which the variety of their interests and possible setbacks arising due to the identified problem can be directly served by the proposed solution (Callon, 1986b; Ramiller, 2007). Interessement consists of processes that attempt to "lock in" other actors as allies or supporters into roles that are defined for them by the focal actor in the network (Ramiller, 2005). If successful, interessement "confirms (more or less completely) the validity of the problematization and the alliances it implies" (Callon, 1986b, pp. 209-210) and "is said to produce enrolment" (Ramiller, 2005, p.54). During enrolment the focal actor attempts to coordinate the defined roles aiming to stabilise and strengthen the emerging network. It involves "multilateral negotiations, trials of strength and tricks that accompany the interessement and enable them [focal actor(s)] to succeed" (Callon, 1986b, p. 211). Successful enrolment in networks represents the alignment of the otherwise diverse interests of its heterogeneous actors which suggests that to maintain network stability actors must be willing to participate in specific ways of thinking and acting (Walsham, 1997). Stability is achieved in an actor-network and actor translation is complete when allies are mobilised at which point "the underlying ideas have become institutionalised and are no longer seen as controversial" (Mähring et al., 2004, p. 214). During mobilization the focal actor employs methods for ensuring that allies continue to operate in accordance with their agreement and do not betray its interests (Callon, 1986b). Translation is said to be effective when the focal actor can guarantee predictable and "consistent behaviour" (Latour, 1999, p. 127) of actors in its network which can be manifested as their acceptance and use of the technical artifact as a solution to the common problem (Ramiller, 2005).

We conceptualise technical actors, namely, the CoP and VMS, as those whose interests they represent and inscribe (Walsham 1997) and which are shaped as "a consequence of the relations in which they are located and performed; that is, in, by and through these relations" (McLean and Hassard, 2004, p. 507). ANT is a suitable analytical framework for examining the development of the CoP and VMS as it deals with how organisational forms emerge (McLean and Hassard, 2004). It can provide detailed and precise descriptions of how heterogeneous actor-networks attempting VMS development are built (Bonner and Chiasson, 2005; Rodon et al., 2008). Specifically, ANT looks at the relationships amongst actors as complex social interactions comprising entrepreneurial activities and negotiations (Garud and Rappa, 1994), and as such, it can help investigate how the VMS "come[s] into being and how users and other actors conform, ignore, modify, or usurp the original designers' interests" (Faraj, Kwon and Watts, 2004, p. 189). Furthermore, ANT can help investigate complex actor interactions and associated implications as they unfold during CoP and VMS development which might otherwise be missed in after-the-fact or post-development assessments (Hanseth et al., 2004; Lee and Oh, 2006;

Walsham, 1997). In this paper, we focus on actor translation which we employ as a framework for analysing and explaining the manner in which the CoP-driven VMS development processes unfolded in South Australia. We deem this to be appropriate as technology-in-the-making involves “constant negotiation and renegotiation among and between groups shaping the technology” (Bijker, Hughes, and Pinch, 1987, p. 13). Following Ramiller (2005), it is apparent and intuitive how translation concepts can be applied in providing an account of VMS development because “the analytical task would focus on identifying the efforts of certain focal actors to translate the diverse interests of other crucially positioned parties into alignment with the main thrust of the project’s goals, and the practical moves they undertake to lock in the necessary commitments” (p. 55).

DATA COLLECTION AND ANALYSIS

We adopt ANT as a basic interpretative framework for data collection and analysis. Latour (1999) describes ANT as a “very crude method to learn from the actors without imposing on them an a priori definition of their world building capacities” (p. 20). Given the evolving state of the VMS, its development can be better understood by examining the interpretations of actors as they interact and get tied together by mutual bonds of reciprocity in processes of constructing and maintaining VMS development networks (Allen, 2004; Bijker et al., 1987; Latour, 1999). With ANT, one must closely “follow the actors” in order to understand how actor-network negotiations influence the form that technical artifacts will or will not take (Callon, 1986a). Thus, we used snowballing to identify actors in the CoP-driven VMS development network. Accordingly, we followed actors involved in doing relevant CoP and VMS development work and their relevant deliverables (e.g. technical and collaborative documentation), no matter how heterogeneous they were (Bonner and Chiasson, 2005; Latour, 1999). This allowed us to obtain multiple perspectives and data sources which in addition to ensuring triangulation also reduced the possibility of interpretations being locked into one mindset.

Specifically, actors’ interpretations concerning CoP and VMS development were captured by way of qualitative empirical data which were collected by reviewing supporting documentation including relevant publications and media coverage including newspaper articles, TV and radio interviews, minutes of major consultation meetings, and other materials located at relevant websites. Following Wagner, Galliers and Scott (2004), information attributable to technical non-human actors (e.g. CoP, VMS) was obtained by reviewing relevant documentation (e.g. CoP and VMS development documentation) and interviewing spokespersons. A total of 31 interviews were conducted with VMS developers and users at various ranks. The interviewed users were expected to use the VMS to monitor and enforce the CoP. Interviews were typically one hour in duration, and focused on translation processes and on how specific VMS requirements and functionality would implement the CoP.

The rich and diverse data collected were analysed in an interpretative basis (Walsham, 1993; Walsham, 1995; Walsham, 1995a) (Miles and Huberman, 1994). Data were read multiple times in attempts to capture higher-order generalisations hermeneutically by shifting frequently between the general and the specific. This entailed analyses of how specific elements might influence general patterns of the case of CoP and VMS development and vice-versa (Boland 1985). ANT was found to be particularly useful in helping direct analysis toward improving the understanding of unfolding action. This included identifying and distinguishing the categories of participating actors and their interests, and crucial developments concerning CoP and VMS and actions undertaken by actors based on their interests to react to and affect such developments (Ramiller, 2005; Ramiller, 2007). Consistently with Hanseth and Monteiro (1997), data were sourced from representatives of various actor groups (e.g. representatives of commercial vessel operators, industry associations); we felt justified in doing so as ANT “has a scalable notion of an actor” (p. 190), that is, it “does not distinguish between a macro- and micro-actor because opening one (macro) black-box, there is always a new actor network” (p. 190). Indeed, ANT enabled us to focus “… on the identification of networks of actors, where the networks themselves are seen to become actors, as the scope of analysis widens. This affords a flexible framework that makes the “levels” in implementation research a matter of empirical discovery rather than stipulation, and that helps thereby to foster a greater realism in capturing the action that takes place.” (Ramiller, 2005, p.53).

RESULTS

To explain how the CoP and the VMS were developed, we examine actor interactions by analysing how the translation stages, namely, problematization, interessement, enrolment, and mobilization, unfold. However, we recognise that whilst discussing translation stages sequentially and separately facilitates analysis and presentation, we found that, in practice, these stages operate in a much more fluid and interwoven manner than the following discussion may imply (Mähring et al., 2004).

Problematization

Of the 50,000 vessels currently operating in South Australia’s marine and inland waters, approximately 7,000 contain basic facilities such as toilets and showers, whilst the larger vessels contain facilities such as spa baths, dishwashers, washing machines and multiple galleys. Toilets produce blackwater which is largely comprised sewage whilst galleys, dish washers and other facilities produce greywater which is largely comprised of food waste, soaps and other cleaning products. Whilst blackwater legislation was introduced in 1973, the standard practice was to discharge all of the greywater waste into the water which created both environmental and human health issues particularly when the vessels operate in the River Murray, South Australia's prime source of drinking water. For example, there are over 2,000 private and commercial vessels that operate in the South Australian part of the River Murray which can potentially discharge up to 500 million litres of untreated greywater into the river annually (SAWL, 2009). Discharges were often observed by members of the public in areas such as marinas and swimming areas and present numerous water quality issues such as increased bacterial counts, suspended solids, E.Coli, grease and oil (Mosley et al., 2007). These threats which can damage ecosystems, create algal blooms and contribute to health risks to both human and aquatic life provided a solid and targeted problematization basis for highlighting the potential harm being done to human and environmental health in South Australia (RW, 2009).

To address this problem, the EPA positioned itself as the focal actor in attempts to establish its actor-network with the aim of developing a solution to rectify it. To strengthen the credibility of its problematization, the EPA carried out risk assessment research on South Australia's environmental impact resulting from the wastewater discharges including an analysis of studies conducted around the world (Mosley et al., 2007). This research confirmed expectations that discharges were harmful to both the environment and to the recreational users of marine and inland waters (Mosley et al., 2007). To extend its problematization, the EPA developed a map of actors that could both threaten the quality of marine and inland waters and also be affected by the identified threats. To decide "who to include and who to exclude" (McLean and Hassard, 2004, p. 499) in the map, investigative work was directed at identifying relevant contextualisers (i.e. activities that could potentially lead to environmental harm) followed by extraction of relevant business listings from yellow pages (Ballantine, 2008). For example, in addition to vessels, the facilities that vessels use for refuelling and maintenance (e.g. painting, varnishing, engine repair) were also identified as potentially harmful to the aquatic environment. Actor identification stopped when no further relevant contextualisers could be identified.

Figure 1 shows the map of identified actors. This study did not follow all of these actors individually rather it focused on their representatives. In fact, actors representing the interests of various groups in the (macro-level) actor-networks were spokespersons of other actors in their industry or grouping. This is justifiable as effective translation of actors in actor-networks also entails representation (Ramiller, 2007), meaning that one actor has the ability to claim the "authority to speak … on behalf of another actor" (Callon and Latour, 1981). Following actor identification, the EPA established participation in CoP development as an OPP. The VMS was proposed as the computerised technical artifact to facilitate enforcing the CoP, thereby, assisting the EPA and its actor-network in addressing the identified problem. Having actors traverse the OPP was important to both allow them inscribe their interests into the CoP and, thus, potentially achieve stability in the emerging EPA network.

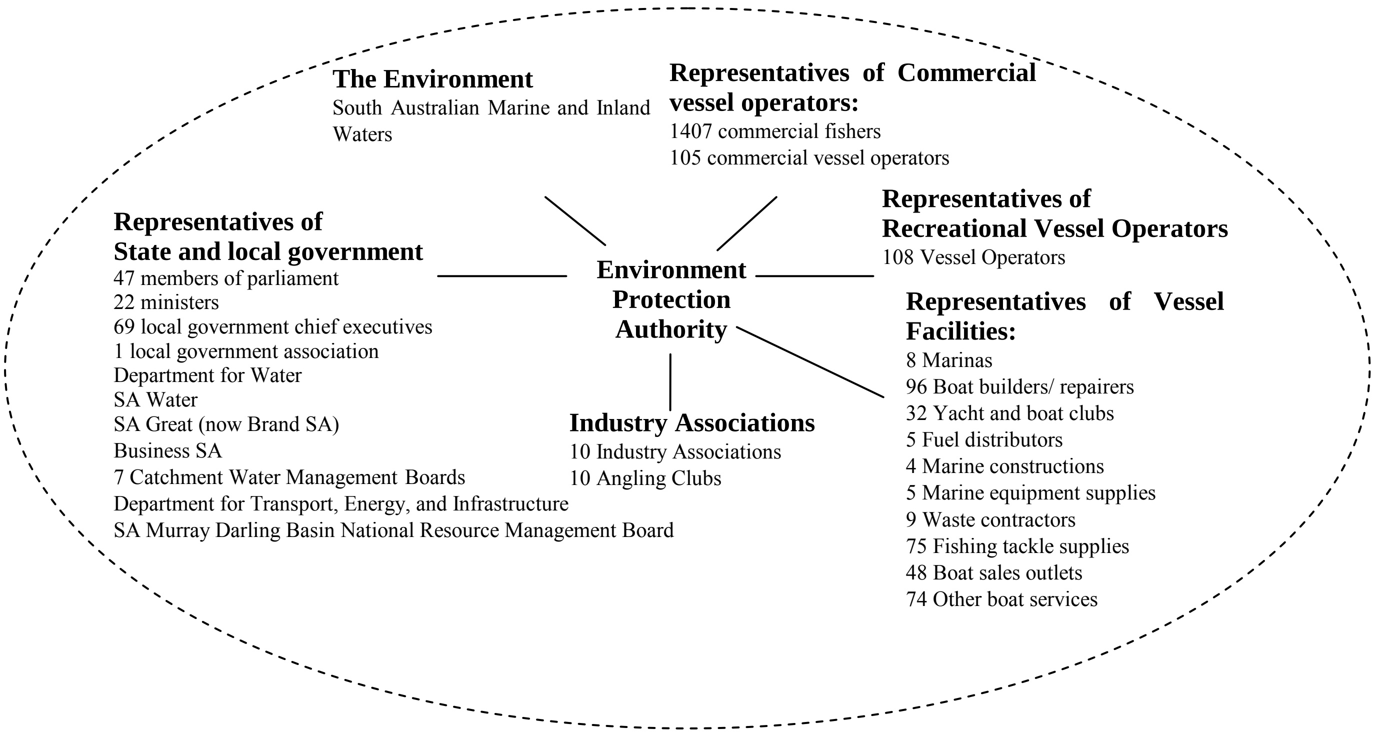

Figure 1. Map of actors

Interessessment

During interessement the EPA undertook numerous activities in attempts to "lock in" actors as allies or supporters. These activities aimed at convincing actors that inland and marine waters had to be protected. This entailed demonstrating to them i) how current practices were harming aquatic resources, ii) how this affected these actors, and iii) how the proposed CoP/VMS would assist in addressing these issues. To achieve interessement, the EPA established a micro actor-network, the external advisory group (EAG), comprising 25 key actors representing business, commercial and recreational vessel operators, vessel facilities, state and local government and industry associations. The EAG were fully translated into the EPA network, that is, they recognised the problem that the EPA was trying to address and the CoP/VMS as the proposed solution whilst acknowledging the EPA as the legitimate focal actor. The EAG fully mobilised to act in accordance with EPA requirements.

The role assigned to the EAG was twofold: i) to provide valuable input on the development of the CoP and hence promote regulation of South Australia's aquatic environment, and ii) to act as a 'spokesperson' on behalf of the EPA to provide information to the relevant prospective actors in attempts to show them the negative impact that wastewater and other environmentally damaging activities could cause to the environment. To achieve its role, the EAG mobilised by developing a draft CoP which underwent several iterations within the EAG (PWWQ, 2004; PWWQ, 2004a; PWWQ, 2004b; PWWQ, 2004c; PWWQ, 2004d; PWWQ, 2004e; PWWQ, 2004f; PWWQ, 2004g; PWWQ, 2004h). Upon completion, as part of the consultation processes, the draft CoP was released to both prospective actors identified during problematization (Figure 1) and the wider public for comments with the aim of reaching and convincing new actors to join the emerging EPA network. Printed advertisements, media releases, awareness articles and interviews with EPA/ EAG spokespersons were published in the popular press and featured in radio and TV (BW, 2005; EPA, 2005; EPA, 2005a; EPA, 2005c; Phillips, 2005; PLT, 2005; PPR, 2005; SET, 2005; WCS, 2005; YPCT, 2005). Public meetings, talks and information sessions were also organised for the members of various groups including commercial and recreational vessel operators, vessel facilities operators, and industry associations (MP, 2005; Times, 2005; WN, 2005). In response to expressions of interest, the EPA sent out letters explaining the formal consultation process concerning the CoP including information concerning the CoP itself, invitations to public forums and workshops, and documentation about how actors could inscribe their interests into the emerging CoP (EPA, 2005; EPA, 2005a; EPA, 2005c).

Enrolment and mobilization

Achieving successful enrolment in its network was critical for the EPA as it meant aligning otherwise diverse interests of heterogeneous actors and getting them to willingly participate in specific ways of thinking and acting (Walsham, 1997). Evidence suggests that the EPA was successful in enrolling industry associations and wider government in its network. For example, actors such as the South Australian Murray-Darling Basin Natural Resources Management Board (SAMDB NRMB), Standards Australia, Boating Industry Association of South Australia (BIASA) and Houseboat Hirers Association (HHA) pledged their support for EPA's CoP/VMS development efforts. They mobilised resources supporting these initiatives. SAMDB NRMG provided $20,000 to support research trials for greywater treatment systems on vessels which could inform CoP development and be used in vessels (EPA, 2008a) whilst BIASA and HHA committed to promote the CoP and SAMDB NRMB-funded research results at their actor-networks (NRMDSA, 2008). Standards Australia mobilised by creating a new standard, the AS4995 Standard for Greywater Treatments Systems, to ensure that actors such as boat manufacturers, vessel owners and operators comply with the CoP, thereby, facilitating their enrolment and mobilization in the EPA network (EPA, 2009; SA, 2009; SA, 2009a; SAWL, 2009).

The enrolment and mobilization of individual vessel owners, operators and facility operators was challenging as it entailed behavioural change. In the past, few vessel owners and operators had been concerned or even aware of the environmental impact resulting from wastewater discharges as polluting activities were part of standard practice. Enrolment and mobilization in the EPA network meant that these actors would now have to take specific CoP-compliant actions (e.g. discharge greywater at specific pump out stations) or even pay for AS4995-compliant greywater treatment systems to reduce the environmental impact of their vessels. In response to interessement activities undertaken by EPA/EAG as part of public consultation, numerous submissions were received from vessel facility owners and operators and even members of the public which were incorporated into the CoP or responded to with reasons when proposed changes could not be accommodated. This is indicative of growing enrolment and mobilization of respondents into the EPA network which culminated with refinements of the CoP and VMS requirements. To incentivise enrolment and mobilization further, rebates were offered to vessel owners and operators to participate in trials of greywater treatment systems whilst exemplar complying commercial operators were offered free advertising within various industry associations' member bases and in popular media (e.g. print, radio and TV) (NRMDSA, 2008). To ensure the wider enrolment and mobilization of vessel owners and operators, the EPA announced a schedule of deadlines making CoP compliance mandatory and legally enforceable. The VMS was used in this process as a regulatory monitoring tool to identify compliant actors and facilitate legal pursuit of offenders (e.g. using correspondence management features). Recognising the practical difficulties that some actors may face to ensure timely compliance (e.g. low water levels preventing vessels from accessing docks to fit greywater treatment systems), the EPA adopted a "soft landing approach". Accordingly, they would look leniently (e.g. by extending compliance deadlines) on actors that can demonstrate that they have tried to comply with the CoP rather than those who appear to be deliberately not trying, and advise and help rather than penalise them (EPA, 2009a; SAWL, 2009). Non-compliance could result in Environment Protection Orders and constitute an offence under the Act (e.g. punished with fines) (Ballantine, 2008; Novak, 2007).

Whilst evidence was emerging that the CoP and VMS were shaping the behaviour of human actors (e.g. recreational and commercial vessel operators), the latter did also shape the manner in which VMS evolved. For example, the CoP applies to recreational and commercial vessel operators in different ways. Consequently, the VMS operates via two different modules, each applying to recreational and commercial vessels, respectively. Due to their large numbers, recreational vessels are subjected to routine random audits by EPA whilst commercial vessels are biennially surveyed by South Australian Government's Department of Transport, Energy and Infrastructure (DTEI) which require compliance with additional regulation beyond that which is expected by EPA's CoP.

Using the CoP and VMS for compliance monitoring, EPA undertook random vessel audits in 2007-08 (DTEI, 2007; EPA, 2008b; RN, 2007). Although many actors were found to be in breach of the CoP, the breaches were generally minor with evidence suggesting that these actors had mobilised, though insufficiently (MP, 2007; Piscioneri, 2007). As a long term solution to compliance monitoring of commercial vessels, DTEI mobilised by coordinating its systems with EPA's VMS to facilitate data sharing. In this manner, DTEI can incorporate EPA's CoP compliance into their biennial survey to ensure ongoing mobilization of commercial vessels (EPA, 2009a; RN, 2007; SAWL, 2009). By incorporating CoP compliance into routine random audits and regular surveys, the EPA are attempting to ensure that the CoP "becomes institutionalized" (Mähring et al., 2004, p. 214) which would be indicative of network stability. However, current compliance evidence suggests that at present enrolment and mobilization of vessel owners and operators is incomplete though still ongoing. For example, currently, over half of commercial vessels and over a quarter of private vessels in the River Murray are fully compliant with the CoP. Translation of many actors in this category, thus, remains incomplete.

DISCUSSION AND CONCLUSION

Using ANT, we have examined attempts of developing a CoP and the VMS, a Green IS that helps regulators enforce the CoP. We conceptualise this as a process of creating stable networks of heterogeneous actors that are tied together by mutual bonds of reciprocity, and that engage in organisational negotiations, and political decision-making determining relations and hierarchies as they effectively develop both the CoP and VMS (Bonner and Chiasson, 2005; Latour, 1999). This conceptualisation helps improve current understanding of how and why a CoP-driven VMS can succeed (or fail) to be developed. Actor translation has progressed under EPA auspices which has become recognised as a focal actor in this process. EPA roles have been critical and effective as evidenced with the fact that EPA references "continue to dominate" and have become "matter of fact – something so ingrained within [the CoP and VMS development] community… that its presence is indisputable and obvious" (Latour 1999, p. 307). EPA references are expected to continue to dominate until translation in its network is complete and the CoP/VMS jointly become an uncontested black box (Bonner and Chiasson, 2005; Latour, 1999).

The EPA provided a specific setting, i.e. social implications of environmental protection (or lack thereof), for the technical, i.e. the CoP-driven VMS, thereby encapsulating the two as "twin results" of its network building efforts. With systematic consultation resulting in incremental changes to emerging legislation, actors responsible for preventing wastewater pollution were given opportunities to inscribe their interests into emerging legislation and the VMS as a compliance tool, and were, thus, willing to adopt sustainable practices in their commercial or recreational activities. Currently, the EPA is attempting to strengthen and expand its network by enrolling new actors and mobilising existing ones thereby enhancing its stability. In its regulator's capacity, EPA roles were facilitated by its vested legislative power, environment protection legitimacy, and ability to apply urgency influences to enforce legislation. This study contributes by highlighting the value of ANT in general, and translation in particular, as compelling tools for illuminating complex interests, emergent causality, reciprocalities, and organisational interaction processes through which Green IS can be developed. It also contributes by integrating ANT and Green IS development with the introduction of sustainability legislation in an environment protection context. Organisations in an increasing number of industries seek to collaborate using Green IS to support their relations (Bengtsson and Ågerfalk, 2011; Watson et al., 2010; Watson et al., 2011). The effective development of these artifacts is extremely important if collaboration efforts are to succeed (Rodon et al., 2008). Thus, there is a significant need for these organisations to better understand how Green IS development processes unfold. By focusing on the development of a specific type of Green IS as an illustration from one cross industry/public sector collaboration, this paper, thus, also contributes by adding to prior literature and responding to calls for further research in this area (Faraj et al., 2004; Hanseth et al., 2004; Hanseth and Monteiro, 1997; Lyytinen and King, 2006; Yoo et al., 2005).

We appreciate that a limitation of this paper is that its South Australian focus only includes a single actor-network thereby potentially providing limited insights for generalising to other Green IS development contexts. However, as an analytical framework ANT is not well suited to a generalisation objective. We recognise that further research is needed that investigates other types of Green IS both from other perspectives in Australia (e.g. bringing in wider and deeper focus on newer, non-focal, actors that are not fully explored in our study) and in other contexts to address this limitation. Nevertheless, we also argue that, given the wide range of information sources and the rich nature of data collected, our findings can be transferable to similar Green IS settings. ANT can help identify and trace development processes which can reveal insights to managers and policy-makers concerning the manner in which social, strategic, and managerial alternatives as well as technical development efforts are considered and the ways in which actor actions and reactions emerge and are managed for ensuring effective and efficient actor participation and management in Green IS development networks (Bengtsson and Ågerfalk, 2011; Watson et al., 2010; Watson et al., 2011).

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