EXPLORING THE INTERCONNECTIVITY OF RISK MANAGEMENT, THE HUMAN ELEMENT, AND ACTION RESEARCH: A CANADIAN ARCTIC PERSPECTIVE

Elizabeth K. Clouter, Lecturer
Marine Institute of Memorial University of Newfoundland,
P.O. Box 4920, St. John's, A1C 5R3 Canada
eclouter@mi.mun.ca

Abstract

In recent decades, the shipping industry, described by the International Maritime Organization (IMO) [1] as "the most international of all the world's great industries and one of the most dangerous" (p. 401) has undergone significant change and momentous growth, improved training, and substantial regulatory oversight. Extensive risk management (RM) protocol notwithstanding, accidents still occur [2, 3], with 75% deriving from human factors [4, 5]. In a fundamentally people-based industry, RM and the Human Element, and therefore potential Human Error (HE), are intrinsically linked. Maritime RM is highly regulated with the ISM Code, MARPOL, SOLAS, and the IMO's Formal Safety Assessment (FSA) process all examples of the regulations and guidelines designed to proactively offset risk and prevent tragedy. Nevertheless, traditional maritime sector RM protocol relies heavily upon historical data which, in addition to the inherent undesirability of dependency, involves multiple other weaknesses. HE has been likened to a breakdown in technical reliability [7] where humans, in their susceptibility to inappropriate response in the face of disturbances to normal operations, act essentially as risk factors [6]. Recent perspectives on safety increasingly consider the Human Element as only one of a "network of errors" in a safety causation chain [7, p. 14]. In the Arctic, where unknowns are extensive and experience navigating them is not, this distinction is especially noteworthy. Strengthened and deeper connection with the Human Element, in conjunction with databank reinforcement and population, therefore appear fundamental to safety improvement efforts [6]. With particular focus on the Arctic, this paper explores whether Action Research is an appropriate methodology to (i) improve facilitation of tasks identified as necessary to mitigating the insufficiency of existing historical databases and (ii) contribute to safety improvement efforts and augment current RM protocol by bringing together the knowledge base of maritime stakeholders as representatives of the Human Element.

Key words: Action research, Data collection, Human element, Human error, Risk management, Arctic

Introduction: Action research

Action Research (AR), considered a "powerful tool for industry-academia collaboration" [8, p. 1], is a proactive data acquisition strategy based on the mutual improvement and broadening of knowledge and practice through their interplay with one another [9]. AR's problem-centered research approach merges 'theory and praxis', identifying a problem, postulating solutions, arriving at an action plan, executing that action plan, and then reassessing in a continuous cycle [9,10]. See Figure 1. Traditional research models typically hinge upon empirical testing and inductive and deductive hypotheses derived from scientific theory, as well as from quantitative, often via mathematical means [11], resulting in a clear division between the research and (i) implementation process and (ii) the roles of researchers, participants, and practitioners. AR departs from this approach by instead emphasizing the value of ongoing collaboration and the importance of group relations as a basis for research and problem solving [9, 12]. Moreover, AR participants are actively involved in the research process themselves and as such act as co-researchers as well as co-subjects [8, 9]. Ultimately, the Action Researcher is the principal investigator who facilitates dialogue to foster reflective analysis among participants to help achieve holistic understanding by all stakeholders. However, in addition to myriad roles including planner, listener, synthesizer, and reporter, the Action Researcher also provides the academic theory and methods necessary to suit a given research situation. Touted as the future's dominant research methodology [14], AR's inherent blend of real situations with experimental studies arguably produces the most 'active' researcher, i.e., one who is involved in the research process, has personal stake in problem resolution [10], and in turn more willingly embraces new ways of thinking and problem-solving through direct involvement in solution-creation [9, 11]. Studies in both the healthcare and software engineering contexts further support the AR approach as a bridge to the gap between theory, research, and actual practice [8, 12].

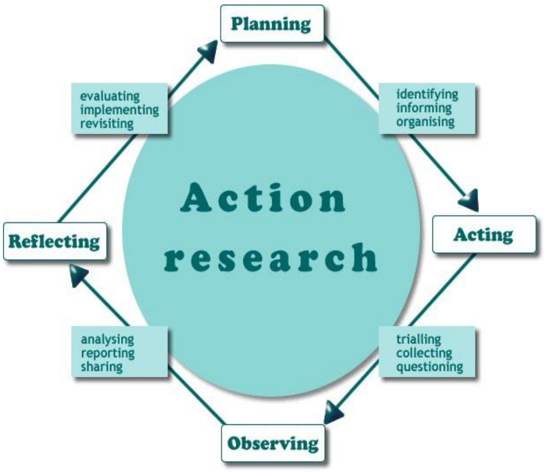

Figure 1: Action research cycle [Adapted from 9,11,12].

Since its inception in the 1940s, AR's core tenets have broadened and proven productively transferable to common goal and consensus development in practical applications such as strategic, action, and business planning; organizational efficiency improvement, as well as client group effectiveness within large corporations; education, healthcare and community initiatives; and even policy research and national governments [11, 13, 14]. Entire AR networks now exist, including the Boston University School of Management and the Cornell Participatory AR Network as well as various highly reputed AR groups such as Action Learning, Action Research, Project Management (ALARPM) and publications such as the *International Journal of Action Research*. Further, AR is emerging in industry-funded research domains such as transportation, tourism, engineering, and information technology [10, 14]. Therefore, while maritime-specific AR is currently lacking, as a research approach worthy of consideration for connecting RM to the Human Element, to organizational goals, and therefore to potential increased safety and to marine research-related knowledge bases, AR appears to have notable merit. Figure 2 illustrates a potential marine-context AR cycle.

AR and proactive RM

Recognition of the need for a more proactive approach to RM and in turn to best practices' development and shipping governance in general is not a new one [15, 16]. Kingston's 2016 crown address to the IMO regarding the Polar Code (PC) and RM Insurance [17] reinforces what is now a commonly held view: that the traditional RM regulatory process is usually slow, initiated by a triggering event and quite often not wholly implemented until another disaster reinforces recommendations made following the initial event [17]. Current protocol is further clouded by strong criticisms such as that of the US National Commission on the Deepwater Horizon disaster being the result of chronic industry and government complacency and inattention to safety [16]. This backdrop, in combination with the shipping industry's continued exponential growth curve trajectory [18] further emphasize the importance of a rigorously ongoing proactive approach to RM and maritime safety where knowledge gaps and inconsistencies clearly exist [5].

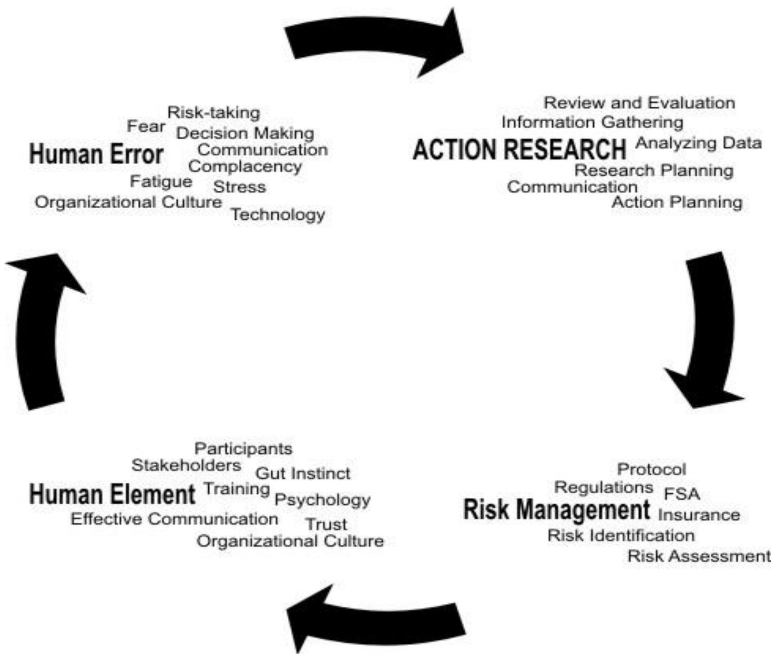

Figure 2: Action research inquiry process as applied to shipping safety, risk management, and the human element. By Author.

Data collection and flaw

Proactive approaches to data acquisition include consistent seasonal reviews and near-miss reporting [6, 7]. Indeed, while dependence on post-accident historical data in RM is in itself a limitation, so is the data it yields since it represents what is overall a very small number of shipping events. While a post-accident safety investigation has undisputed value [20], critical incidents, or "near-misses" are in fact 600 times more likely to occur than accidents [19] and therefore offer even greater potential for learning [7, 21]. Studying critical events can lend insight into how accidents were avoided as well as provide a deeper understanding of the human decision-making process that accompanied dealing with the non-routine and potentially dangerous circumstances where a near-miss event could have become an accident [7, 22] and in turn prompt studies such as Overgard, Sorensen, Nazir, and Martinsen's [19] whose assessment of human decision-making during DP operations, for example, informs of the importance of experience in critical decision-making as it affords more situational awareness and therefore more time to consider potential strategies for resolving the problem and thereby more optimally managing the situation. Grote's 2007 [22] study on uncertainty management underscores the need to view disturbances as opportunities to learn and expand individual as well as organizational competencies, further indicating that the continued collection of such data is critical. Yet, according to the 2016 IAMU-FSA study [15], of 157 accidents which occurred north of 60 between 2000-2015, only 4 safety investigations by the Transportation Safety Board (TSB) were fully investigated. That is to say, while 4 occurrences met the requirement of *full* investigation, 154 did not, instead garnering only basic data collection status, and effectively translating to 154 missed opportunities to acquire more extensive and valuable data.

Benefits notwithstanding, near-miss report examination as a data-collection system has flaws. For example, Hilduberg [23] reports both an over-abundance of near-miss reports on everyday events, resulting in less meaningful data, and, due to fears of accountability, an under-reporting of events that have true learning potential such that distortion arises and serious systemic problems are not identified or addressed. As a result, lessons that should be conveyed are often not, instead becoming lost in the "information noise" associated with life at sea and putting into question whether anything has been learned from an actual near-miss incident [24, 20]. Studies also show an increased risk of communication failure among people who lack experience [21] which is in parallel with the intrinsic lack of experience with Arctic sailing. That is to say, while dependency on historical data is in itself flawed, in the Arctic where situations are generally new, prior historical data from which to draw important safety considerations unique to that setting may not exist. Consequently, the application of Bayesian and other modelling techniques is often necessary. However, models and historical data are ultimately just tools to help make better decisions and "it's dangerous to put too much faith in them" [25, p. 3]. Because of the risk of flaw, therefore, multiple methods of data collection are preferable [26]. Action Research has the potential to be an additional and effective tool for data collection and reporting as well as for levelling possibly flawed data, especially in the case of the historical-data deprived arena of Arctic shipping.

Mitigating data insufficiency and flaw through AR

Research shows an AR strength is its ability to curtail information loss through its systematic approach to the capturing and retention of data. Studies by Polo et al and Kauppinen [as cited in 8] found that in an engineering software-context, information loss was reduced due to the iterative AR stages of data collection, debriefing, reflecting, and recording. Additionally, the inherent AR components of structure and organization were found to better ensure process continuity and review [8, 34], points of significance in light of limitations such as manpower or resources amongst official bodies which may therefore limit the extent and breadth of reporting. Further, information retention is improved through the AR hallmark of effective information housing and organizing [12], akin to the Cloud concept of storing Big Data from a plethora of sources. In both cases, the goal is to retain, process and disseminate information so as to make it useful in practical applications and to also ensure, through iterations and a orderly approach to data management, that information does not stagnate. To that end, the cumulative goal to initiate action through information sharing with the relevant larger community, achieved through multiple means including reports, presentations, workshops, and steering committees, was asserted as an AR strength [8, 12, 34].

AR's collaborative core approach meshed with what Psaraftis [as cited in 15] highlights as the vast knowledge and expertise that exist within the broader seafaring community presents another opportunity to widen the information-gathering net. By seeking out, initiating, and promoting discourse with players beyond the immediate scene of an accident, for example, the AR team, partly comprised of stakeholder participants, has the potential to be the connector of information that may otherwise exist only in pockets [10]. Meaningful dialogue with operators who found themselves in situations similar to those identified in an accident or near-miss situation combined with systematic record-keeping of their experiences can supplement findings derived from not only traditional post-accident RM participants such as superintendents and immediate crew but also from initiatives such as the Arctic Shipping Best Practice Information Forum and the Arctic Marine Advisory Board (AMAB), which aim to assess use of the PC from initial stages, prior to incidents. Similarly, the October 2017 Canadian Marine Advisory Council (CMAC) conference includes a session on "ship operators' experiences of using the Polar Code," suggesting a strong and proactive focus to the PC [28] and attesting to the appropriateness of the equally proactive and collaborative AR methodology as a means of augmenting knowledge-sharing, beyond that derived from select gatherings. The Sustainable Transportation Action Research Team (START) [29] program in British Columbia is a further example of successful industry-relevant AR. Its blend of a variety of research methods, ranging from quantitative and qualitative statistical analyses to stakeholder interviews and discussion with a wide range of stakeholders, suggests that through the same interdisciplinary approach, AR also has the potential within the marine sector to harness the human in data acquisition so as to help identify trends and best practices.

AR and the human element

The human being is "at the center of the shipping enterprise from routine deckhand duties to IMO policy decisions" [21, p. 7].

In 2014, Arctic shipping accounted for only 9.3% of global shipping traffic [30]. It can be deduced, therefore, that the majority of future Arctic-going seafarers lack adequate prior knowledge of operating in this new environment, characterized by unique and unpredictable challenges and the need for amplified environmental consciousness. Compounding this lack of experience, are changes in both vessel design and operations, which can lead to reduced situational familiarity and in turn negatively impact decision-making [19]. Additionally, while digitization in the maritime industry lags behind that of other industries, it is increasingly evident in many applications [31] with data driven decision-making (DDDM) fast becoming a vital tool for any industry's success and the emergence of the Industrial Internet of Things (IIoT)-based safety-critical applications such as the Norway's More Maritime Cluster changing the landscape of what many feel is a relatively traditional industry where use of technology in general is surrounded by skepticism [31, 32]. Not only is the technology learning curve increasing in both breadth and speed, but studies also show that the reduced active human involvement associated with automated systems contributes to increased error with the caveat that, innately, human beings are not perfectly rational decision-makers [19, 21]; studies demonstrate non-optimal decision-making and judgment even in situations where all the necessary information is available to do so [19, 22]. A variety of factors including limitations on resources and time; over-confidence and lack of appreciation of missing skills and knowledge; stress and fatigue; and individual differences in situational awareness and familiarity can all detract from the safety critical approach to problem-solving [21, 22]. Moreover, even the perception of risk can differ, with Bailer et al's 2006 study [as cited in 21] finding that shore-based staff believed accident risk was twice likely as did crew, for example.

Recent RM views of "safety science" therefore slant away from traditional accident modelling approaches, such as the sequential or latent-failure model [7, p. 15] which tend to place HE and the individual component at the root of accident causation, and more towards a "no blame" culture that recognizes this variability in human performance and risk perception and the resulting need to predict changes in the shape of risk so as to pre-empt failures and harm [7, 21]. Because the HE catalyst is only one of many elements in a complex and inherently dangerous working environment, focusing on risk elimination to understand how we succeed is thought to be less beneficial than focusing on what is being done right and why people did what they did [21, 6, 7]. Subsequently, cultivating a connection with the Human Element so as to share potentially instructive, clarifying input that draws from the expertise of a variety of stakeholders, including that of the routine operator, is central to heightening awareness and improving understanding of both the "human out of the loop" issues connected with "disruptive" technologies as well as to variations in decision-making and risk perception. Studies show, however, that, while new training trends demonstrate the importance of instituting a "just" safety culture from senior management down and emphasize the serious injury or loss of life that can otherwise result, the fear of speaking up, or the "cover up culture," is an obstacle [7, 20, 23]. Thus, while input sharing is vital, trust also plays a significant role in the imparting of information as indeed, "People can bring together or push apart" [21].

AR as collector and connector

A recent PC commentary indicated the importance of "linking everything together" [17, p. 8), and of the value of the research community working with industry in a collaborative approach to gather knowledge. Similarly, the objectives of the AMAB's [33] Terms of Reference include the goal of functioning as a forum for open and transparent consultation and discussion with valid industry stakeholders. Likewise, AR is rooted in bringing together people who are mutually interested in solving or improving a situation [9] and engaging in meaningful dialogue to enable understanding at the "micro" level of those in the trenches whose voice may in turn find representation in the "macro" view of the wider industry, thereby expanding understanding of the issues as well as the range of relevant stakeholders. However, situations and parameters can influence perception and how an issue is approached and thus managed. A salient AR strength in this regard is that an effective Action Researcher will carefully note findings from participants in *various* settings and go on to reflect on and consider linkages as well as disparities [9, Hironaka-juteau, et al , 2006 as cited in 27]. For example, an Action Researcher positioned at a conference where 20 operators are speaking on their experiences using the PC or new technology, would carefully observe and note the type of commentary put forth, but would then seek out opportunities to speak with operators in a smaller group setting and again at an individual level so as to ascertain whether setting, numbers, group composition, and level of privacy indicate differences in findings, as demonstrated in Breu and Hemingway's 2015 industry-based Participatory AR study [10].

While there are no maritime-transportation based studies to date which utilize AR in their methodologies toolkit, numerous studies exist which do recognize the AR approach as an effective catalyst for nurturing trust [11, 12]. Action Researchers are described as effective levelers who allay others' fears and invite participation in a "we're in-it together" approach so as to assuage fear amongst stakeholders [9], a point of significance given findings that even the promise of anonymity does not sufficiently encourage people to speak up about near-miss incidents, as the threat to an organization's professionalism is sometimes simply too intimidating. Yet, unless accountability is managed and seafarers can report without fear of blame, real systemic problems can go unaddressed [22, 23]. To this end, studies suggest that long-term industrial affiliation enriches the research process where an open-forum collaborative approach grounded in rapport fostered trust and encouraged discourse, as well as engendered the ability to pick up valuable information "on the fly" [10, sec. 5.2]. The AR methodology and setting, ideally an established hub, where information can be shared freely and anonymously in an environment underscored by trust and a mutual desire for improvement and growth would enable the possibility of uncovering commonality issues and needs as well as new research foci.

Conclusions

AR is based on the active collaboration of researcher and stakeholder/co-researcher regarding practical concerns in a mutually beneficial situation of co-learning optimized by the establishment of trust and openness. Its goal is to improve a situation through collaborative efforts where the Human Element and the experience and input its participants bring to the research process is recognized and respected. In instances of meager or non-existent data, where multiple methods of information acquisition should be utilized, AR's interdisciplinary characteristics make it a reasonable strategy for adding to the existing knowledge bank used in both RM and safety protocol in general as well as for helping to off-set data flaw. Additionally, AR's systematic approach to data collection and storage can lead to efficiencies' identification through taking stock of, clarifying, and disseminating the input of the experienced so as to uncover new findings and trends. Moreover, because such information can be inadequately spread and instead remain in pockets with insufficient exploration, connectivity, and transparency and because such stagnation can in turn potentially skew data and therefore accuracy, discussions and the availability of a forum to share, maintain currency, and promote information and process continuity would be advantageous. As safety deserves all possible means of support, especially in new dimensions such as the Arctic, the findings of this paper suggests the need for (i) recognition of AR as a viable research methodology to promote both information-sharing and connection with the Human Element; (ii) more AR studies in industry, especially maritime; and (iii) ideally, the establishment of an AR nexus so as to offer an organized and fruitful environment dedicated to facilitating a maritime-focused research process and to better give voice to the collective and varied broader community of maritime industry stakeholders.

Reference list

[1] Hetherington, C., Flin, R., & Mearns, K., Safety in shipping: The human element, *Journal of Safety Research,* 2006. doi: 10.1016/j.jsr.2006.04.007
[2] Akhtar, M.J., & Utne, I.B., Modelling the impact of human fatigue on the risk of shipping accidents, *Transport Research Arena Conference*, 2014, Paris, France.
[3] Yang, Z.L., Wang, J., & Li, K.X., Maritime safety analysis in retrospect. *Maritime Policy and Management: The Flagship Journal of International Shipping and Port Research*, 2013, Vol. 40, Issue 3, pp. 261-277. doi:10.1080/03088839.2013.782952
[4] Chauvin, C., Human factors and maritime safety. *Journal of Navigation*, 2011, Vol. 64.
[5] Lloyd's, *The challenges and implications of removing shipwrecks in the 21st century*, 2013. Retrieved from https://www.lloyds.com/news-and-insight/risk-insight/library/technology/wreck-report
[6] Arslan, V., Kurt, R.E., Turan, O., & De Wolff, L., Safety culture assessment and implementation framework to enhance maritime safety. *Transportation Research Procedia,* 2016, Vol. 14, pp. 3895-3904.
[7] Bhardwaj, S., Resilience engineering and adaptive safety, *Seaways*, 2017, Mar., pp. 4-16.
[8] Petersen, K., Gencel, C., Asghari, N., Baca, D., & Betz, S., Action research as a model for industry-academia collaboration in the software engineering context, 2014, 29th *IEEE/ACM International Conference on Automated Software Engineering*, Sweden.
[9] Stringer, E. T., *Action research,* 4th edition, 2014, Los Angeles, CA: Sage.
[10] Breu, K., & Hemingway, C., Researcher-practitioner partnering in industry-funded participatory action research. *Systemic Practice and Action Research,* 2005, Vol. 18, Issue 5. doi: 10.1007/s11213-005-8482-6
[11] Afify, M.F. Action research: Solving real-world problems. *Tourism and Hospitality Research*, 2008, Vol. 8, Issue 2, pp. 153-159. London, England: Palgrave.
[12] Blumberg, B, Cooper, D.R., & Schindler, P.S., *Business research methods*, 2005, pp. 278-298. Maidenhead, NJ: McGraw-Hill.
[13] Hart, E., & Bond, M., *Action research for health and social care: A guide to practice,* 1995. Buckingham, England: Open University Press.

[14] Huang, F.Q., & Zeng, W., Comments on systematic methodologies of action research in the new millennium: A review of publications 2000-2014. *Action Research,* 2017, Vol. 0, Issue 0, pp. 1-20. doi: 10.1177/1476750317691103
[15] Parsons, J.R., Kuzmin, V.E., & Clouter, E.K., *Application of formal safety assessment in polar maritime transportation: Namely routeing, emergency procedures, and human factors*, 2017. IAMU 2015 Research Project No. 20150304.
[16] United States National Commission, *BP Deep Water - The Gulf oil disaster and the future of offshore drilling: Report to the President*, 2011. Retrieved from https://www.gpo.gov/fdsys/pkg/GPO-OILCOMMISSION/pdf/GPO-OILCOMMISSION.pdf
[17] Kingston, M. *The Polar Code and its implementation: Education about requirements and fostering best practice in operational safety to make it work - Insurance industry contributions*, 2016. London, England: All Party Parliamentary Group.
[18] Det Norske Veritas [DNV]. *DNV report: Shipping 2020,* 2012. Retrieved from http://www.lngbunkering.org/lng/sites/ default/files/2012_DNV_Shipping%202020%20-%20final%20report.pdf.
[19] Overgard, K.I., Sorensen, L., Nazir, S., & Martinsen, T.J., Critical incidents during dynamic positioning; Operators' situation awareness and decision-making in maritime operations, *Theoretical Issues in Ergonomics Science,* 2015, Vol. 16, Issue 4, pp. 366-387. Retrieved from http://dx.doi.org/10.1080/1463922X.2014.1001007
[20] Chowdhury, F. R. Marine casualty investigation. *Seaways*, 2013, April. London, England: The Nautical Institute.
[21] Skuld. *The human element: A guide to human behavior in the shipping industry*, 2010. Glasgow, Scotland: Witherby.
[22] Grote, G., Understanding and assessing safety culture through the lens of organizational management of uncertainty, *Safety Science*, 2007, Vol. 45, pp. 637-652.
[23] Hilduberg, O.J. Why near-miss reporting fails, *Seaways*, 2017, March, Vol. 12.
[24] Szymanski, K. Beyond human error, *Seaways,* 2014, December. London, England: The Nautical Institute.
[25] Heires, K., *Risk management: Flaws in the data*, 2017. Retrieved from http://www.rmmagazine.com/2017/04/03/flaws-in-the-data/
[26] Susman, G.I., & Evered, R.D., An assessment of the scientific merits of action research, *Administrative Science Quarterly*, 1978, Vol. 23, pp. 582-603.
[27] Mahoney, M. Engaging with industry: Collaborative action research as a useful tool in facility management, knowledge, and learning. *Management, Knowledge and Learning International Conference, 2014*, June. Portoroz, Slovenia.
[28] Canadian Marine Advisory Council. Agenda: Prairie and Northern Region Canadian Marine Advisory Council, 2017. Montreal, Quebec: Transport Canada.
[29] Sustainable Transportation Action Research Team [START], 2017. Retrieved from https://sustainabletransport.ca/
[30] Eguiluz, V.M. A quantitative assessment of Arctic shipping in 2010-2014, *Scientific Reports*, 2016, Vol. 6. doi: 10.1038/srep30682
[31] *Six maritime startups that are changing the game,* 2017. Retrieved from https:/knect365.com/talentandtraining/article/1149354e-68d9-4e74-9f91-a900ac869526/6-
[32] Wang, H., Osen, O. L., Li, G., Li, W., Dai, H-N, & Zeng, W. *Big data and industrial internet of things (IIoT) for the maritime industry in northwestern Norway,* 2015. IEEE.
[33] Arctic Marine Advisory Board [AMAB], Terms of reference, 2016. Ottawa, ON: DFO.
[34] Momme, J, & Hvolby, H. An outsourcing framework: Action research in the heavy industry sector, *European Journal of Purchasing and Supply Management*, 2002, Vol. 8, pp. 185-196.