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Perceived Risks of Energy Pipelines: A Proposal for More Integrated Risk Management

by

Bernard Ho Wai Wong

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Abstract

This project attempts to answer the following questions:

- Is there a risk perception gap regarding the safety of energy pipelines?
- How can the gap be closed if there is one?

Research on perceived risks of pipelines is important because the public's risk perceptions and the resulting attitudes, behaviors, and judgements can significantly impact projects and operations. Existing risk perception research has not included pipelines. This project integrates literature review and survey data analysis to identify patterns of perceived risks of pipelines. The project finds that the perceived risks of pipelines are strongly influenced by psychological, sociological, and anthropological factors. Also, this project finds that the media plays a large role in influencing the public's perceptions. This project proposes strategies for managing the perception gap, including 1) improving perceived benefit distribution, 2) improving familiarity, 3) acknowledging and accommodating the public's different world views, and 4) systematically managing perceptions in the media.

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Chapter 1 Introduction

Until 2015, North America has been experiencing an increase in crude oil production, including the increasing production in the Canadian oil sands (Rogoff, 2016). As a result, the energy industry faces challenges in accessing markets, and one of the reasons is limited pipeline capacity (NRC, 2016a). Pipeline safety performance measures suggest that pipeline transport is relatively safe, but the public still have concerns about safety and the environment which are accentuated by a series of high-consequence pipeline incidents across North America, including the Kalamazoo River oil pipeline spill in 2010.

Energy pipeline development, like many other types of major energy development, often faces significant local opposition. Local concerns are often not what opinion leaders and decision-makers assume, and climate change is not an important factor that drives local opposition (Cleland, Bird, Fast, Sajid, & Simard, 2016). The research by Cleland et al. (2016) has found that important factors that drive local opposition include the following:

- Health and safety concerns (i.e. potential impacts to health and wellbeing as well as potential injuries and deaths)
- Local environmental impacts (i.e. potential spills; potential impacts on air, land, water, habitats, animals, and plants; and potential impacts on local and traditional economies)
- Benefit distribution (i.e. potential local economic benefits, including jobs, in exchange for the risk exposure)
- Consultation, communication, and local involvement in decision-making

(Cleland, Bird, Fast, Sajid, & Simard, 2016)

Energy pipeline development may be most susceptible to local opposition relative to other types of energy development because pipelines cross long distances and come across many different communities with different risk perceptions, attitudes, and world views. Therefore, this project studies the perceived risks of energy pipelines that contribute to local opposition. For this project, "risks of energy pipelines" refer to risks to the health and safety of people and the environment along pipeline rights-of-way if a leak or rupture that results in a release of products occurs. A pipeline incident can cause serious injuries, fatalities, property damages, and environmental damages. Health, safety, and environmental issues often overlap and are inseparable because one's health and safety is at risk in an environment that is at risk.

1.1 What is risk perception?

"Risk perception" refers to the general public's intuitive risk judgments rather than technical experts' risk assessment to characterize and evaluate hazardous activities and technologies (Slovic, Perception of Risk, 1987). The "perception gap" refers to "the occasional gap between our fears and the facts caused by the instinctive way we perceive and respond to risk" (Ropeik, 2017, p. 1).

Disagreements over risks include how risk is defined, analyzed, evaluated (i.e. accepted), and interpreted. Pipeline experts and the public define risks of energy pipelines differently. The journal article *Some dimensions of risk not often considered by engineers* by Redmill (2002) states that "[n]otions of risk lie on a scale ranging from wholly objective and measurable to wholly subjective and socially constructed. Even in engineering and science usage is not consistent" (Redmill, 2002, p. 272). Generally, technical risk assessment is viewed as more objective and risk perception is viewed as more subjective.

The Canadian Energy Pipeline Association (CEPA) and the National Energy Board (NEB) claim that pipeline transport is the safest and most efficient method to transport large volumes of oil and gas (CEPA, 2015; CEPA, 2016a; NEB, 2017a). Indeed, according to the CEPA's *Pipeline Industry Performance Reports*, in Canada, there has been zero serious public injuries and fatalities caused by a rupture for more than 60 years, and 99.999 per cent of the volume of product is transported safely (CEPA, 2015; CEPA, 2016a). Yet, according to EKOS's *Canadian Attitudes toward Energy and Pipelines* survey, less than 70 per cent of Canadians and just over 50 per cent of Quebecers perceive pipeline transport as safe (EKOS, 2016). Additionally, people may acknowledge that risks of energy pipelines are low, but they are still not inclined to accept the risk for ideological reasons. For pipelines, concerns about risks provide a platform for the debate about energy and economic development versus local environmental protection and global climate change.

1.2 Research Question

This project attempts to answer the following research questions:

- Is there a risk perception gap regarding the safety of energy pipelines?
- How can the gap be closed if there is one?

Research on perceived risks of energy pipelines is important because the public's risk perceptions, attitudes, behaviors, and judgements can significantly impact energy pipeline projects. Understanding risk perception helps with understanding the public's concerns at a fundamental level and can be useful for energy pipeline development project proponents in achieving agreements with involved parties.

This project reviews three key risk perception theories, including *Psychometric Paradigm*, *Cultural Theory,* and *Social Amplification of Risk*. These theories are used to analyze the perceived risks of energy pipelines. Based on the results of the literature review and data analysis, strategies for managing perceived risks of energy pipelines are proposed.

1.3 Relevance to Energy, Economy, and Environment

Perceived risks of energy pipelines are relevant to energy, economy, and environment topics. In Canada, when it comes to energy pipelines, there is a lot at stake. Oil and gas supply most of the energy demand and contribute significantly to the economy, and energy pipelines transport most of the oil and gas.

- **Relevance to Energy:** Oil and gas are essential energy sources for the modern society to function; therefore, safe, reliable, and economical energy transport by pipelines is essential to meet the energy demand of the modern society. In 2016, oil has accounted for 30.6 percent of energy used in Canada and 38.0 per cent of energy used in the US, and natural gas accounts for 27.3 per cent of energy used in Canada and 31.5 percent of energy used in the US (BP, 2017). The world energy consumption is estimated to increase by 48 per cent between 2012 and 2040, and it is estimated that fossil fuels (mainly oil, gas, and coal) will account for more than 75 per cent of world energy consumption through 2040 (EIA, 2016). Pipelines, which transport 97 per cent of oil and gas in Canada and 70 per cent of oil and gas in the US, are critical energy infrastructure (CEPA, 2013; Furchtgott-Roth & Green, 2013).
- **Relevance to Economy:** As discussed, oil and gas meet the majority of the energy demand, and pipelines transport most of the oil and gas; therefore, safe, reliable, and economical energy transport by pipelines is important economically. Canada is the sixth

largest oil producer in the world, with overall oil production of more than 3.9 million barrels per day in 2015 (CAPP, 2015). In 2015, the energy industry accounts for 7.3 per cent of Canada's gross domestic product and 8 per cent of the US's gross domestic product (NRC, 2016b; API, 2016). Canada's oil and natural gas industry, which has invested $81 billion in capital projects and is forecasted to invest $44 billion in capital projects in 2017, is the largest private sector investor in the country and has contributed an estimated $15 billion in royalty payments, land payments (bonus payments), and corporate and municipal taxes (CAPP, 2017). Energy transmission pipelines have contributed $11.5 billion to Canada's GDP in 2015 (CEPA, 2016a).

Although Canada is one of the largest oil producers in the world, Canada has imported 736,000 barrel per day in 2015, which is a 16 percent increase from the previous year (NEB, 2016). This is caused by a lack of pipeline capacity connecting Canadian crude oil production in Western Canada to refineries in Eastern Canada (NRC, 2016a). A major challenge of a major energy pipeline development project is local public opposition.

- **Relevance to Environment:** The public demands that oil and gas be transported safely and reliably, and, for energy pipeline transport, the goal is zero incidents (CEPA, 2007). A pipeline incident can cause serious injuries, fatalities, property damages, and environmental damages. High-consequence energy pipeline incidents like the Kalamazoo River oil pipeline spill in 2010 have damaged the perceptions and reputations of energy pipeline companies and regulators. Additionally, concerns about the impacts of oil and gas production, transport, and consumption on the environment. Also, climate change, although not an important factor that drives local opposition, raises doubts regarding the modern society's continual dependence on fossil fuels and the need for new energy pipelines.

Pipeline development, like most energy, economic, and environmental issues, provokes disagreements between proponents and opponents. The debate about new pipelines has been basically about economy versus environment and has become political (Bell, 2016; Baluja, 2017). Pipeline development would not be so contentious if it did not have significant potential economic benefits and risks to people and the environment.

1.4 Background

Risk management involves managing technical and non-technical risks. The background provides an overview of technical and non-technical risks and describes how risk perception fits into risk management.

1.4.1 Technical Risks

Maintaining technical integrity of energy pipelines, or pipeline integrity, is important to prevent pipeline failures and to protect people and the environment along the pipeline rights-of-way. Bale and Edwards (2000) define "technical integrity" as follows:

> *"Technical integrity is concerned with the development of the design, such that it is carried out by well trained competent (assessed) personnel in accordance with sound recognised practices and procedures and that there is adequate provision by way of reviews and audits to ensure the design intent is unimpaired in any way that could cause undue risk or harm to people or damage to the environment."* (Bale & Edwards, 2000, p. 88)

Maintaining pipeline integrity involves managing technical risks. For the purpose of pipeline integrity, "risk" is defined by the *CAN/CSA-Z662-15 Oil and gas pipeline systems* standard as "a compound measure, either qualitative or quantitative, of the frequency and severity of an adverse effect" (CSA, 2015, p. 489). Additionally, "risk" is defined by the *ASME B31.8S-2016 Managing System Integrity of Gas Pipelines* standard as "measure of potential loss in terms of both the incident probability (likelihood) of occurrence and the magnitude of the consequences" (ASME, 2016, p. 41). Technical risk is expressed with Equation 1 as

$$\text{risk} = \text{probability} \times \text{consequences} \quad \text{(Equation 1)}$$

where the "probability" is "likelihood of an event occurring" like an estimated number of failures per length per time, and "consequences" is "impact that a pipeline failure could have on the public, employees, property, and the environment" (ASME, 2016, p. 40).

"Failure" refers to the "general term used to imply that a part in service has become completely inoperable; is still operable but is incapable of satisfactorily performing its intended function; or has deteriorated seriously to the point that it has become unreliable or unsafe for continued use" (ASME, 2016, p. 38). A failure can be either a leak or a rupture. "Leak" is defined as "unintentional escape of [product] from the pipeline. The source of the leak may be holes, cracks, separation or pullout, and loose connections" (ASME, 2016, p. 38). "Rupture" is defined as "complete failure of any portion of the pipeline" (ASME, 2016, p. 41). A pipeline failure can cause serious injuries, fatalities, property damages, and environmental damages. A failure is caused by the one or more pipeline integrity threats, which include but are not limited to external corrosion, internal corrosion, stress corrosion cracking, manufacturing defects, construction defects, equipment failures, third-party damage, incorrect operations, weather-related and outside forces (ASME, 2016).

Technical experts develop and execute pipeline integrity management programs, which include activities like integrity assessment (in-line inspection, direct assessment, and pressure testing), technical risk assessment, and prevention and mitigation. As technical risks increase with pipelines that are larger, longer, and operating at higher pressures in high-population and unusually sensitive areas, a continual improvement of technical risk management is especially important.

Companies collect performance measures (like volume transported versus volume spilled, number of injuries and fatalities, number of integrity assessments performed etc.) to continually evaluate and improve pipeline integrity management programs and to help identify unexpected results and new threats. Additionally, companies report performance measures to regulators and industry associations to share with the public about safety performance.

1.4.2 Non-technical Risks

Non-technical risks emerge from interactions with the public, regulators, governments, non-governmental organizations, and environmentalists (Esteves, 2015). Energy pipeline development projects face significant non-technical risks because of challenging relationships with communities and the general public. Non-technical risks account for about 70 to 75 per cent of cost and schedule failures in oil and gas projects because of lost businesses and stakeholder-related issues (Brewer & McKeeman, 2012; Esteves, 2015; Valiant Business Media, 2015). It is expected that the costs associated with project approval processes and local environmental impact management will continue to increase, which will negatively affect project economics, competitiveness, costs of energy, and returns to governments who are resource owners (Cleland, Bird, Fast, Sajid, & Simard, 2016).

The public's perceptions, attitudes, behaviors, and judgements can affect policies, laws, and project approval decisions that can significantly impact energy pipeline projects; therefore, risk perception is a significant source of non-technical risks.

An integrated assessment of technical and non-technical risks enables more informed decisions. As technical and non-technical risks increase, especially when accessing resources that have once been inaccessible and transporting these resources to new markets, there is little room for errors. Managing non-technical risks can decrease costs associated with delays and security and reduce frustration and conflicts. Based on the above, a significant part of managing risks is understanding and managing risk perception, which is the topic of this project.

Chapter 2 Literature Review

This section covers the academic work on risk perception related specifically to the research questions and reviews the history of what has already been researched on the topic.

In the middle to late 1900's, risk perception research has been used to explain the public's concerns about chemical and nuclear technologies (Slovic, Perception of Risk, 1987). Recently, risk perception research has been used to explain the public's concerns about terrorism after September 11, 2001 (Jenkin, 2006). However, risk perception research has not been used to explain the public's energy pipelines regarding energy, economic, and environmental issues.

Managing risks involves managing the public's risk perceptions. This may be a paradigm shift in a company in which technical experts make most decisions. Technical experts have criticized risk perception as "irrational fear…based on a mistaken assessment of…risks" and "the public has been driven insane over fear" (Slovic, 1987, p. 285). However, the public's risk perceptions and the resulting attitudes, behaviors, and judgements can significantly impact energy pipeline projects, so risk perception should be understood and managed.

To better understand the role of risk perception in managing risks of energy pipelines, this project reviews the following three key risk perception theories:

- Psychometric Paradigm
- Cultural Theory
- Social Amplification of Risk

The Psychometric Paradigm, which is a psychological approach, explains why an individual perceives an activity or a technology to have higher or lower risk relative to other activities and technologies. The Cultural Theory, which is a sociological and anthropological approach, explains how a group becomes concerned about an activity or a technology and not others, as well as how risks become politicized. The Social Amplification of Risk provides a comprehensive framework that unites technical factors; psychological and sociocultural factors; institutional factors; and communication to explain the public's processing of information about a risk.

2.1 Psychometric Paradigm

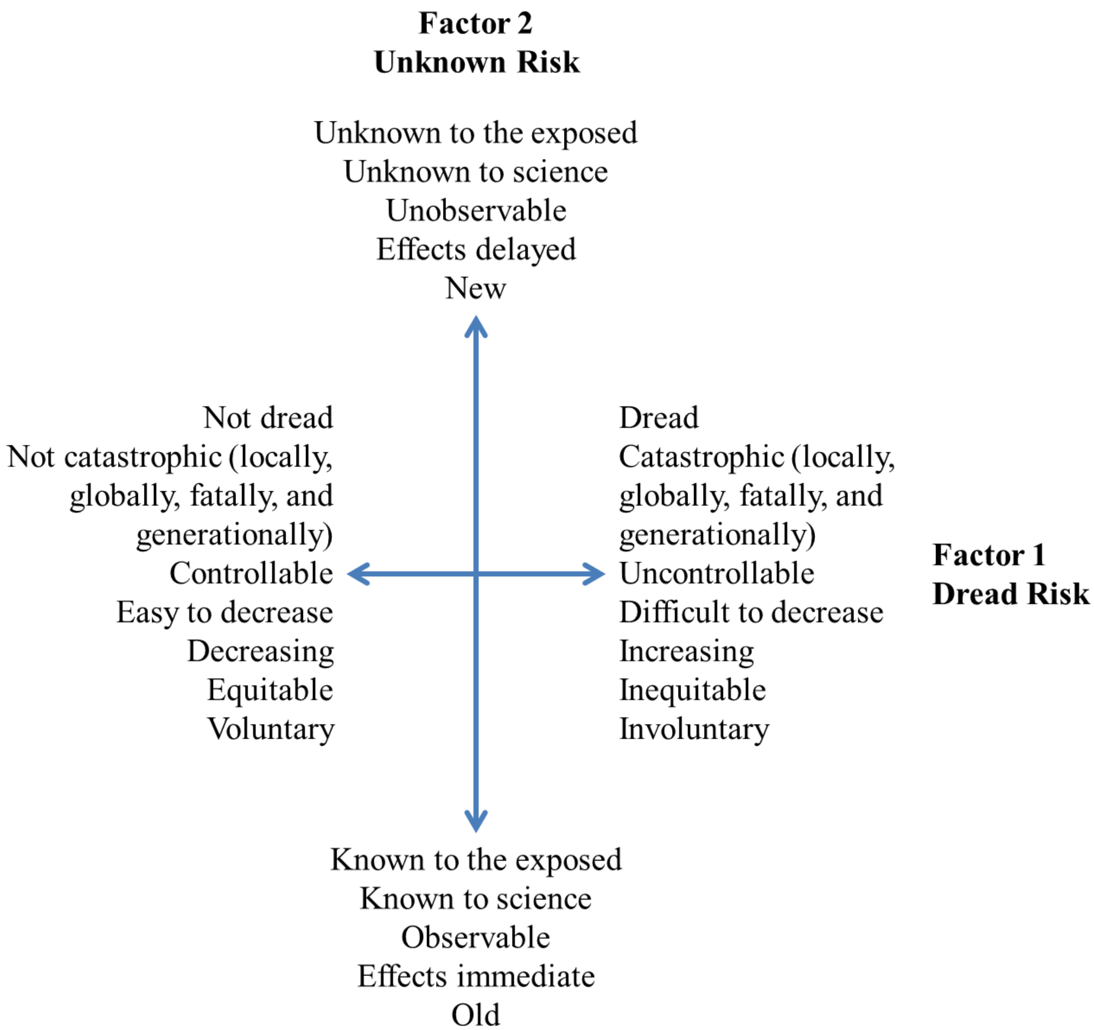
The Psychometric Paradigm is applicable for explaining an individual's concerns about risks of energy pipelines. According to Psychometric Paradigm, individuals' risk perceptions, attitudes, and behaviors regarding activities are based on three factors: 1) dread, 2) unknown, and 3) the number of people exposed to the risk.

Slovic (1987) defines Psychometric Paradigm as follows:

> *The psychometric paradigm…uses psychophysical scaling and multivariate analysis techniques to produce quantitative representations or "cognitive maps" of risk attitudes and perceptions. Within the psychometric paradigm, people make quantitative judgments about the current and desired riskiness of diverse hazards and the desired level of regulation of each.* (Slovic, Perception of Risk, 1987)

The Psychometric Paradigm explains and compares individuals' risk perceptions of different hazardous activities and technologies based on "dread" and "unknown" factors. Figure 1 shows a cognitive map that includes the dread and unknown risk factors and their characteristics:

Figure 1: Cognitive Map for Unknown and Dread Risk Model Psychometric Paradigm



(Slovic, Perception of Risk, 1987)

- Factor 1 is dread risk, which is defined as "perceived lack of control, dread, catastrophic potential, fatal consequences, and the inequitable distribution of risks and benefits" (Slovic, 1987, p. 283). Dread risk has the following characteristics:
    - Catastrophic: The degree to which a risk event is perceived as locally, globally, fatally, and generationally catastrophic
    - Uncontrollable: The degree to which the risk is perceived as uncontrollable

- Difficult to decrease: The degree to which the risk is perceived as difficult to decrease
- Increasing: The degree to which the risk is perceived as increasing
- Inequity: The degree to which the risk and benefit distribution is perceived as inequitable
- Involuntariness: The degree to which the risk exposure is perceived as involuntary or forced

(Slovic, Perception of Risk, 1987)

High dread risk is characterized as catastrophic (locally, globally, fatally, and generationally); uncontrollable; difficult to decrease; increasing; inequitable; and involuntary (Slovic, Perception of Risk, 1987). Risks of energy pipelines can be described as relatively high dread. If a gas pipeline ruptures in a high population density area, the consequences are serious injuries and fatalities caused by thermal effects. If an oil pipeline ruptures in an environmentally sensitive area, the consequences are contamination of drinking water, vegetation, and fish.

- Factor 2 is unknown risk, which is defined as "hazards judged to be unobservable, unknown, new, and delayed in their manifestation of harm" (Slovic, 1987, p. 283). Unknown risk has the following characteristics:
    - Unknown to the exposed: The degree to which the risk is perceived as unknown to the exposed
    - Unknown to Science: The degree to which the risk is perceived as unknown to science

    - Unobservable: The degree to which the consequences are perceived as unobservable
    - Effects delayed: The degree to which the consequences are perceived as delayed
    - New: The degree to which the risk is perceived as new

    (Slovic, Perception of Risk, 1987)

  High unknown risk is characterized as unknown to individuals exposed and science; unobservable, effects delayed; and new (Slovic, Perception of Risk, 1987). Risks of energy pipelines can be described as relatively high unknown. Most energy pipelines are underground and "out of sight, out of mind", and most of the public pay little attention to the existence of energy pipelines unless there is an incident or a proposed new pipeline.

- Factor 3, which is not shown on the cognitive map, is associated with consequences in terms of the number of people exposed to the risk (Slovic, Perception of Risk, 1987). If a gas pipeline ruptures in a high population density area, or if an oil pipeline ruptures in an environmentally sensitive area, a large number of people can be impacted. For a gas pipeline, a rupture in a high population density area can result in many serious injuries and fatalities. For an oil pipeline, a rupture in an environmentally sensitive area, such as a water body, can contaminate drinking water, vegetation, fish, or other ingestion pathways and negatively affect the health and wellbeing of those exposed.

The Psychometric Paradigm suggests that expressing risks in terms of risk values (like the numbers of fatalities per kilometer of pipelines per year and volume transported versus volume spilled) and comparing these risk values with those of other activities and technologies may not be effective in changing public opinions because "[p]eople's perceptions and attitudes are determined not only by…statistics…but also by the variety of quantitative and qualitative characteristics reflected in [the cognitive map]" (Slovic, 1987, p. 285). Additionally, risk perception research suggests that providing probability values (like the likelihood of failure) may not be effective in changing public opinions because the public cares a lot more about the severity of consequences rather than the low likelihood of a risk. Aven and Renn (2009) suggests that the public places greater emphasis on uncertainties (i.e. known unknowns and unknown unknowns) and stakes of the consequences like health, wellbeing, and death and places lesser emphasis on probabilities and expected values (Aven & Renn, 2009). This helps explain the public's "tendency…to hear or retain only consequence potential and not the more difficult-to-appreciate improbability" (Muhlbauer, 2004, p. 353).

Before this project, no research has attempted to place energy pipelines in the cognitive map. However, the *Taxonomic Analysis of Perceived Risk Modeling Individual and Group Perceptions Within Homogeneous Hazard Domains* by Kraus and Slovic (1988) has found that "a high-speed train carrying explosive chemicals near a city is perceived to be much more like hazards associated with nuclear reactors than like other railroad hazards" (Kraus & Slovic, 1988, p. 453). Therefore, the research by Kraus and Slovic (1988) suggests that the concerns are mostly about the transported product (i.e. explosive chemicals like oil) rather than the mode of transport (i.e. pipeline versus rail) and that energy transport, including pipeline and rail transport, is perceived as highly risky. Additionally, the research suggests that the comparison of oil transport by pipeline and by rail may have limited effects on influencing the perceived risks of energy pipelines.

2.1.1 Signals

For activities and technologies that are perceived as relatively more dread and more unknown, incidents (events that result in undesirable consequences) and even near hits (events that could have resulted in undesirable consequences) are signals for more incidents to come. An incident or a near hit involving an activity or a technology that is perceived as relatively more dread and more unknown is “a warning signal for society, providing new information about the probability that similar or even more destructive mishaps might occur within this type of activity” (Slovic, Perception of Risk, 1987). The public’s memories of past events and ability to imagine future events influence risk perceptions, attitudes, judgments, and behaviors (Muhlbauer, 2004). Activities and technologies in the upper right quadrant of the cognitive map (i.e. high dread risk and high unknown risk) in Figure 1 will have a higher signal potential (i.e. stronger signals when an incident or a near hit happens) than those in the bottom left quadrant of the cognitive map (Slovic, Perception of Risk, 1987).

As discussed, the risks of energy pipelines are perceived as relatively more dread and more unknown and therefore energy pipelines have a higher signal potential, which helps explain the widespread public concern about pipeline safety after a pipeline incident or near hit (Muhlbauer, 2004). Every pipeline incident or near hit provides a “cautionary tale” and supports the notion that “more pipelines are an unacceptable risk” (Brooks, 2014).

Pipeline incidents that result in serious public injuries and fatalities (on top of property damages and environmental damages) have very high signals and may cause powerful social, political, and legal reactions. There have not been such incidents in Canada (CEPA, 2015; CEPA, 2016b), but there have been a few in the US. The following events are examples of high-signal incidents that have caused strong public response in the US (PHMSA, 2016):

- **Bellingham, Washington:** An Olympic Pipe Line Company’s pipeline ruptured in Bellingham, Washington on August 19, 2000 and released about 237,000 gallons of gasoline into Hanna Creek and Whatcom Creek that flowed through Whatcom Falls Park.

The gasoline ignited and created a fireball that extended longer than a mile along Whatcom Creek. The failure killed three people – two ten-year old boys and an 18-year old man – and injured eight people (NTSB, 2002). The pipeline rupture also killed more than 100,000 aquatic organisms and wildlife, damaged the habitats for these aquatic organisms and wildlife, and killed and injured vegetation (EPA, 2016).

Olympic Pipe Line Company and Equilon Pipeline Company (which owns and operates Olympic Pipe Line Company) pleaded guilty to one felony violation under the *Hazardous Liquid Pipeline Safety Act* and two misdemeanor violation under the *Clean Water Act* (McClary, 2003). It was the first time that a pipeline company was convicted under the *Hazardous Liquid Pipeline Safety Act* and the first time that pipeline company executives were sentenced to jail in a pipeline rupture case (OIG, 2003). The companies paid $112 million to settle all federal criminal fines and most civil claims (McClary, 2003).

- **Carlsbad, New Mexico:** An El Paso Natural Gas Company's natural gas transmission pipeline ruptured by the Pecos River near Carlsbad, New Mexico on August 19, 2000 and killed twelve people, including a five-year-old girl (Parker, 2004). The pipeline rupture cost $998,296 in property and other damages or losses (NTSB, 2003) and "contributed significantly to the extraordinarily high California spot gas prices" in 2000 and 2001 (FERC, 2003). At the time of writing this paper, this pipeline rupture was the most deadly natural gas transmission pipeline rupture in the US (PHMSA, 2017).

The paper *The Pipeline Industry Meets Grief Unimaginable: Congress Reacts with the Pipeline Safety Improvement Act of 2002* by Parker (2004) describes the dread of parents who lost their children to pipeline incidents and how these events demonstrate previously unrecognized risks of pipelines. Parker (2004) also described that an isolated accident is potentially catastrophic, and catastrophic consequences have damaged public confidence and trust, which caused difficulties in locating sites for new pipeline development projects and, ultimately, new statutes and regulations (i.e. the Pipeline Safety Improvement Act of 2002) (Parker, 2004). Today's highly prescriptive (therefore costlier) pipeline integrity regulations in the US are the direct results of these incidents (PHMSA, 2016; INGAA, 2017).

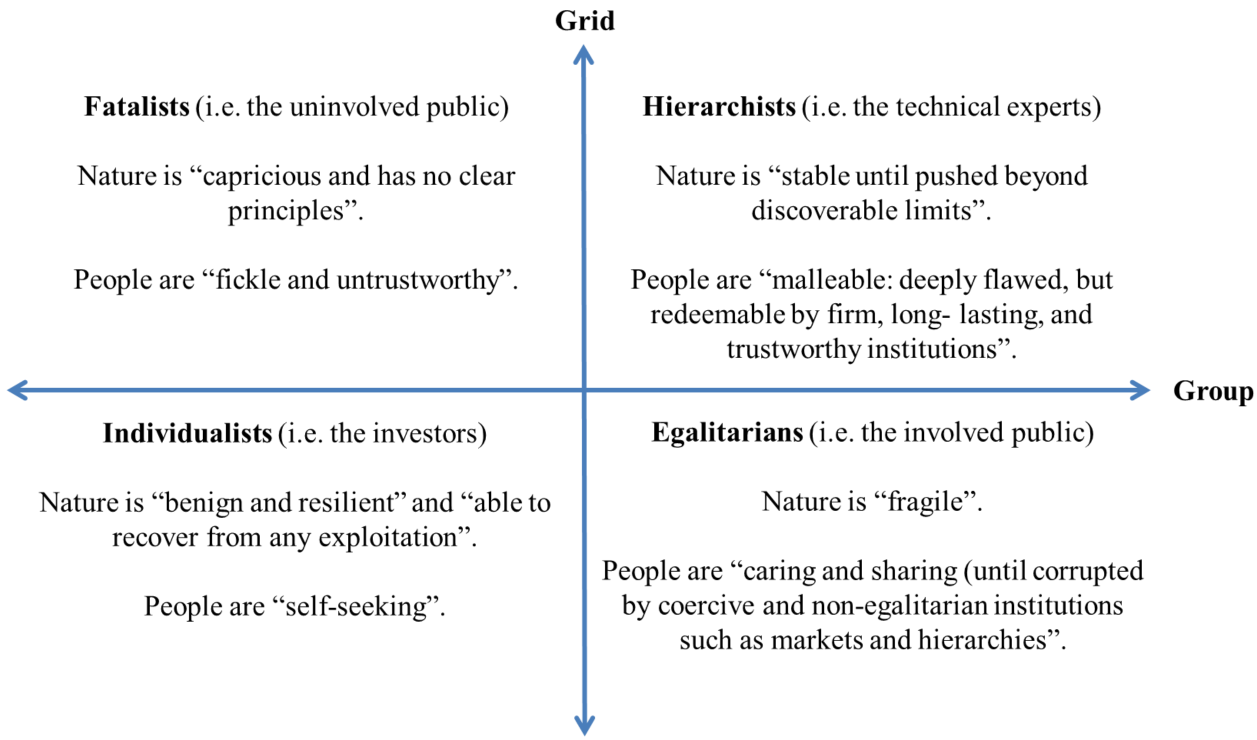
For more information about the process that begins with the initial risk event to the impact, see the Social Amplification of Risk in Section 2.4.

2.2 Cultural Theory

Whereas psychometric research suggests that concerns about risks are not only about technical risk statistics and performance measures, sociological and anthropological research suggests that some of the concerns about pipeline safety are not even be about the risks; rather, the concerns about pipeline safety justify actions for other social or ideological concerns (Slovic, Perception of Risk, 1987). For pipelines, concerns about risks provide a platform for the debate about energy and economic development versus local environmental protection and global climate change. People may acknowledge that the risks of energy pipelines are low but may still do not accept the risks for other social or ideological reasons such as the opposition to oil and gas consumption and production.

According to the Cultural Theory, people's world views, way of life, ideologies, deeply held values, and beliefs determine "what to fear…and how much to fear it" (Wildavsky & Dake, 1990, p. 22), and individuals perceive activities and technologies that endanger their way of life as risky (Wildavsky & Dake, 1990; Oltedal, Moen, Klempe, & Rundmo, 2004). Cultural Theory explains the social construction of risk in terms of cultural biases and social relations. Cultural biases are "shared beliefs and values that justify different ways of behaving – that is, as world views corresponding to different patterns of social relations" (Dake, 1992). Individuals' risk perceptions, attitudes, and behaviors can be predicted based on patterns of social relations, which include hierarchical, individualist, egalitarian, and fatalist (Dake, 1992; Ellis & Thompson, 1997). The following map shows the Group and Grid factors that characterize the patterns of social relations:

Figure 2: Grid and Group Model of Cultural Theory



(Carnegie Council, 2000; Thompson, 2000; Rippl, 2002)

"Group" refers to whether individuals are bonded to social units and how involved the individuals are with the group's activities. In a higher group pattern of social relations, individuals are more bonded to a social unit, and in a lower group pattern of social relations, individuals are less bonded to a social unit. "Grid" is the degree to which a social context regulates and restricts individuals' behavior. In a higher grid pattern of social relations, individuals have less behavioral options, and in a lower grid pattern of social relations, individuals have more behavioral options and are increasingly expected to negotiate their own social relations. (Oltedal, Moen, Klempe, & Rundmo, 2004)

Different patterns of social relations have different world views regarding the environment.

- Individualists have the world view that nature is “benign and resilient” and “able to recover from any exploitation” (i.e. “can take anything we throw at her”), and people are “self-seeking” (Carnegie Council, 2000; Thompson, 2000). Individualists believe in fair distribution such that individuals who “put the most in get the most out (as in the joint stock company)” (Carnegie Council, 2000; Thompson, 2000). Individualists view risks as opportunities (Rippl, 2002). Individualists follow the invisible hand and want to be “unconstrained by the rules of a hierarchical institution or the strong demands of a group” (Tansey & O'Riordan, 1999; Thompson, 2000); therefore, individualists oppose regulations and collaboration.
- Egalitarians have the world view that nature is “fragile, intricately interconnected and ephemera”, and people are “caring and sharing (until corrupted by coercive and non-egalitarian institutions such as markets and hierarchies)” (Carnegie Council, 2000; Thompson, 2000). Egalitarians believe in fair distribution such that individuals “start off equal” and “end up equal” (Carnegie Council, 2000; Thompson, 2000). Egalitarians supports a concerted grassroots effort in regulating behaviors based on the precautionary principle (Carnegie Council, 2000; Thompson, 2000; Muldoon, Lucas, Gibson, Pickfield, & Williams, 2015); therefore, egalitarians oppose elite experts and governmental authorities’ decisions that impose high-consequence risks on people, future generations, and the environment (Rippl, 2002). Indeed, the public is increasingly egalitarian and demands improved consultation and communication practices and local involvement in decision-making regarding safety, need, distribution of benefits, local, and environmental impacts. As the report *A Matter of Trust: The role of communities in energy decision-making* by Cleland et al. (2016) states, “[t]he world of elite, centralized decision-making

without local engagement is fast becoming a thing of the past". (Cleland, Bird, Fast, Sajid, & Simard, 2016)

- Hierarchists have the world view that nature is "stable until pushed beyond discoverable limits", and people are "malleable: deeply flawed, but redeemable by firm, long- lasting, and trustworthy institutions" (Carnegie Council, 2000; Thompson, 2000). Hierarchists believe in fair distribution based on "rank and station or…by need…with the level of need being determined by expert and dispassionate authority" (Carnegie Council, 2000; Thompson, 2000). Hierarchists support risk decisions that are justified by authorities and experts (Carnegie Council, 2000; Thompson, 2000; Rippl, 2002).
- Fatalists have the world view that nature is "capricious and has no clear principles", and people are "fickle and untrustworthy" (Carnegie Council, 2000; Thompson, 2000). Fatalists believe that "fairness…is not to be found in this life, and there is no possibility of effecting change for the better" (Carnegie Council, 2000; Thompson, 2000).

These four world views represent different patterns of risk perception, attitudes, judgements, and behaviors regarding environment issues like energy pipeline development based on social or ideological reasons. The research by Ellis and Thompson (1997) has found that the individualist's and egalitarian's world views, which are almost opposite of each other regarding nature, are most applicable for analyzing the debate about prioritizing economic issues versus prioritizing environmental issues (Ellis & Thompson, 1997). Individualists view nature as resilient, so they support more development and oppose more regulations; however, egalitarians view nature as fragile, so they oppose more development and support more regulations (Ellis & Thompson, 1997). Based on the different patterns of social relations, those who prioritize the economy as the more important issue are more individualistic while those who prioritize the environment as the more important issue are more egalitarian.

Energy pipelines' safety records do not effectively change risk perceptions in certain groups because established world views are hard to change and influence how individuals and groups interpret a given piece of information. The Cultural Theory explains why individuals who prioritize environmental protection and individuals who prioritize economic development would interpret the same information and make judgments about risks differently. To pipeline opponents with a strong bias towards the egalitarian world view regarding nature, a low actual failure rate may not mean safety; rather, it may mean "[p]ipeline accidents will continue to happen", and "[i]t's not a matter of if there will be another spill, but when" (Brooks, 2014). On the other hand, pipeline proponents with a strong bias towards the individualist world view, may be frustrated by pipeline opponents' "tendency…to hear or retain only consequence potential and not the more difficult-to-appreciate improbability" (Muhlbauer, 2004, p. 353). In other words, social or ideological reasons affect risk acceptability. Those who support oil and gas development have lower acceptance criteria for risks of energy pipelines than those who oppose oil and gas development.

The finding in the report *A Matter of Trust: The role of communities in energy decision-making* by Cleland et al. (2016) suggest that disagreements among groups with different world views, way of life, ideologies, deeply held values, and beliefs can be difficult to resolve. Concerns about landscape, community, tradition, and health are embedded in values, and there may be little room for negotiation. Achieving the right balance between economic and environment interests and between local and broader societal interests often require trade-offs and compromises; however, at times, local values and broader societal interests may be irreconcilable regardless of the extent of consultation and accommodation. For proposed energy pipelines that cross cross long distances and come across many different communities with different risk perceptions, attitudes, and world views, more resources and time may be required for negotiation. (Cleland, Bird, Fast, Sajid, & Simard, 2016)

2.3 Effects of Personal Attributes and Trust on Risk Perception

It is found that personal attributes and trust affect risk perception. This section reviews the effects of gender, age, location, and trust on risk perception.

2.3.1 Gender

Research shows that men generally perceive lower risks compared to women (Slovic, Trust, Emotion, Sex, Politics, and Science: Surveying the Risk-Assessment Battlefield, 1999; Zelezny, Chua, & Aldrich, 2000). Additionally, research shows that women generally perceive higher environmental risks than men do (Zelezny, Chua, & Aldrich, 2000). Research explains the differences with traditional gender roles and socialization. Traditionally, men are providers for their families and women are caregivers for children (Sato, 2015). Socialization theory suggests that risk perceptions, attitudes, judgments, and behaviors can be predicted by socialization based on gender expectations within the context of culture norms – men are socialized to be more independent and competitive and women are socialized to be more interdependent, cooperative, compassionate, and nurturing (Zelezny, Chua, & Aldrich, 2000). When integrating the socialization theory with the Cultural Theory, traditional gender roles and socialization orient men to be more individualistic and women to be more egalitarian regarding nature (Ellis & Thompson, 1997; Zelezny, Chua, & Aldrich, 2000; Sato, 2015). For example, Morioka (2014) observed that Japanese men were likely to be less concerned about radiation than women after the Fukushima nuclear disaster in Japan. Japanese men were more concerned about employment and economic stability than physical well-being; on the other hand, women were concerned about present and future impacts of radiation on their children (Morioka, 2014). Lastly, the effects of socialization may explain the higher signals of pipeline events with children and young people as victims, like the accidents in Bellingham, Washington and Carlsbad, New Mexico.

2.3.2 Age

The effects of age on risk perceptions, including environmental and climate change risks, are inconclusive (Bonem, Ellsworth, & Gonzalez, 2015; van der Linden, 2017). Nonetheless, in Canada, younger people are generally less interested in working in the oil and gas industry and perceive the industry more negatively compared to older people. As the report by Hussain (2013) has stated, in the Canadian oil and gas labor force, 18 per cent are aged under 35, 42 per cent are aged 35 to 49, and 40 per cent are aged 50 and above, and "the oil and gas industry suffers from a perception problem as young people appear to be shunning the industry in favour of technology companies focused on social media and apps" (Hussain, 2013). The *EY Oil and Gas US Perceptions Study* (EY, 2017) has found that two out of three teens believe that "the oil and gas industry causes problems rather than solves them", and that 44 per cent of people aged 20 to 35 and 62 per cent of people aged 16 to 19 consider a career in oil and gas unappealing (EY, 2017). The survey has also found that younger people generally perceive oil and gas jobs as having fewer opportunities for growth, less long-term financial stability, less positive impact on local and global communities, and less prestige compared to older people do (EY, 2017).

2.3.3 Location

Research suggests that location influences acceptance of risks of an activity or a technology. For example, people in countries where nuclear energy is established and has had no serious incident for a long period perceive lower risks than people in countries where nuclear energy is less established, and this is because of increased familiarity and understanding (UWE, 2014). Similarly, people in Alberta and Saskatchewan are more familiar with the energy industry more and more focused on the economy compared to people in other provinces, so, according to risk perception theories, they are more likely to perceive lower risks of energy pipelines and to accept the risks of energy pipelines compared to people in other provinces (Slovic, Perception of Risk, 1987; EKOS, 2016)

2.3.4 Trust

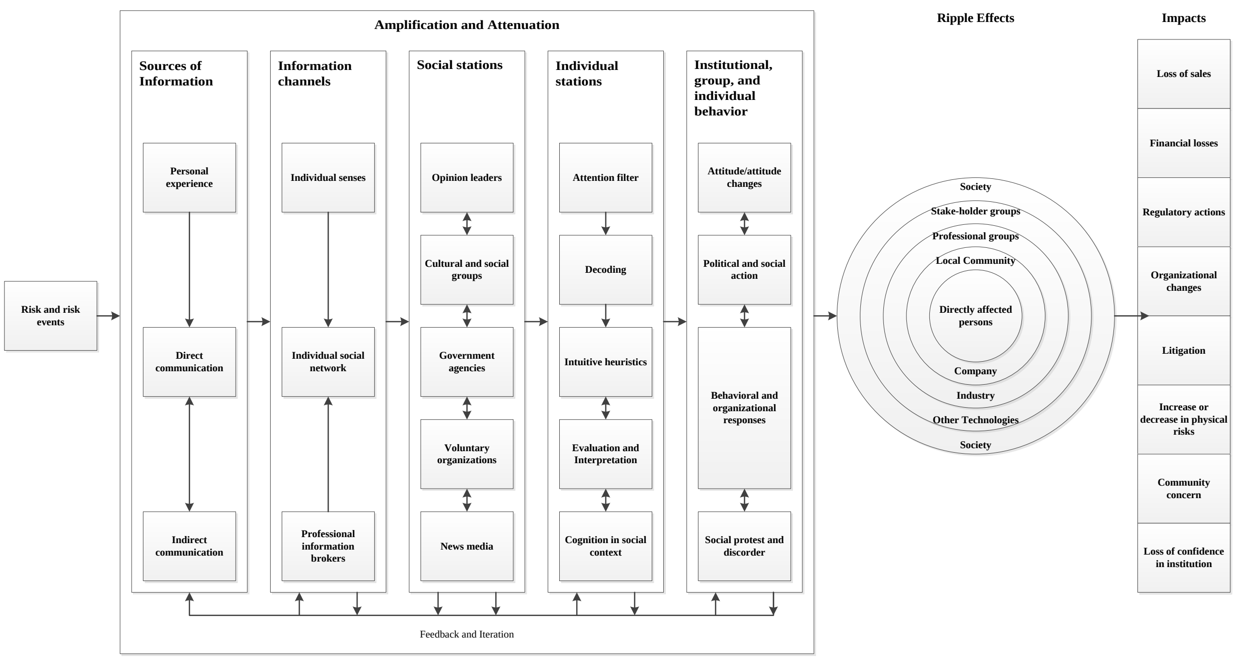
Risk perception is affected by trust. However, communities have a natural tendency to be distrustful of outsiders, and the public's trust in experts, authorities, and the industry, particularly the energy industry, is very low. Explanations of the lack of trust include but are not limited to perceived conflicts of interest, low transparency, and low independence of public authorities as well as ineffective consultation and communication practices. Unfortunately, trust is created slowly and can be destroyed in an instant by an event, so building trust, and therefore improving perceptions, takes time and effort. (Slovic, Trust, Emotion, Sex, Politics, and Science: Surveying the Risk-Assessment Battlefield, 1999; Cleland, Bird, Fast, Sajid, & Simard, 2016)

2.4 Social Amplification of Risk

The Social Amplification of Risk framework integrates technical risks; individual and sociocultural factors; and social institutions like the media to explain how the public's risk perceptions, attitudes, judgements, and behaviors are formed. The Social Amplification of Risk framework shows how signals of a risk event involving pipeline safety cause widespread impacts to the company, the industry, other technologies, and society. The public's perceptions and ripple effects can be amplified when institutions fail to consider the social context of risk when making decisions and communicating information to the public. (Kasperson, Renn, Slovic, Brown, & Emel, 1988; Kasperson & Kasperson, The Social Amplification and Attenuation of Risk, 1996)

The framework for Social Amplification of Risk of pipeline safety is as follows:

Figure 3: Social Amplification of Risk Framework



(Kasperson & Kasperson, The Social Amplification and Attenuation of Risk, 1996)

- **Risk Events:** Social Amplification of Risk begins with a risk event. Risk events involving energy pipeline safety include but are not limited to routine or unexpected releases of products, accidents (minor and major), pollution, exposures, adverse consequences, or near hits. A risk event may also be a release of a new government or public interest group report about pipeline safety. A risk event generates risk signals, and an activity or a technology that is perceived as relatively more dread and more unknown has higher signal potential for significant social and economic impacts.

- **Sources of Information:** Sources of information is either from personal experience or communication. Personal experience can amplify and attenuate the risk. For example, as discussed, people affected by the Fukushima nuclear disaster in Japan perceive higher risks with nuclear technologies (Morioka, 2014). On the other hand, people in Alberta and Saskatchewan are generally more familiar with the oil and gas industry and therefore perceive fewer risks of energy pipelines (EKOS, 2016). If there is no personal experience, an individual's sources of information include other people and the media. Most of society learns about risks and risk events from other people and the media rather than from direct personal experience. In this case, individuals' risk perceptions may be influenced by volume (i.e. the amount of discussion and media coverage), disputes over the information, dramatization, and the symbolic connotations of the information.

- **Information Channels:** Signals are then transmitted through individual senses, social networks, and media. Social networks, which include family members, friends, coworkers, and neighbors, provide reference points for context and perception. The media, which includes televisions, news, and the internet, is a powerful channel of amplification. The media monitors, filters, and sets agendas and tends to cover uncommon and extraordinary risk events like a gas pipeline rupture rather than common and ordinary risk events like smoking. Disproportionate coverage of risk events can amplify the perceived risks of some activities or technologies and attenuate the perceived risks of other activities or technologies.

  Social Stations: Signals are transmitted, amplified, or attenuated by opinion leaders, cultural and social groups, government agencies, voluntary organizations, information offices (public relations), and the news media to individuals. Social institutions and organizations like the pipeline companies, regulators, and non-governmental organizations influence the social amplification or attenuation of risk because they set the contexts of risks and risk issues and manage the risks.

Additionally, the media is a powerful channel of amplification. Individual and group risk perceptions, attitudes, judgements, and behaviors are influenced by the amount of media coverage; the amount of information given, the way in which the risk is described (including the way in which symbols, metaphors are used); the way in which the information is presented and interpreted; and the way in which the argument is presented. The volume of stories related to pipeline development projects, including Keystone XL and Northern Gateway, has increased by 450 per cent in between 2009 and 2013, and a fifth of them are positive in tone while a third of the stories are negative in tone (Cano, 2013). The increased volume and overall negative tone of the coverage is likely a contributing factor to the higher perceived risks of energy pipelines in parts of Canada, especially in parts that are less familiar with the energy industry.

- **Individual Stations:** Individuals interact with cultural and peer groups to decode, evaluate, and interpret the information about the risks of energy pipelines. Both psychological and sociocultural factors simultaneously influence individuals' risk perceptions, attitudes, and judgements and form behaviors for accepting or rejecting the risks.

- **Group and Individual Responses:** When the information is processed, individuals and groups may result in a change in attitude towards the risks of energy pipelines, which drives political and social actions, behavioral and organizational responses, and even social protest and disorder. The risks of pipelines and risk acceptance have become a debate topic between social groups (i.e. individualist versus egalitarian world views) and an issue in political campaigns.

- **Ripple Effects:** The impact of a risk event centers on the victims and spreads to the company, the industry, the regulators, and even other technologies. Ultimately, the impact of a risk event may spread to society in general. For example, Enbridge's failure at Kalamazoo River in Michigan has been a contributing factor in the controversies surrounding Enbridge's Northern Gateway and Kinder Morgan's Trans Mountain pipeline development projects as well as the election of the New Democratic Party government, which is against the Trans Mountain project, in British Columbia in 2017 (Cleland, Bird, Fast, Sajid, & Simard, 2016; Baluja, 2017).
- **Impacts:** The impacts of the ripple effects, which can be far reaching, include loss of business, financial losses, regulatory actions, organizational changes, litigations, increased community concerns, and loss of confidence in institutions. For example, in response to concerns about risks of energy pipelines in Canada, the proposed Northern Gateway project has been rejected, and the federal government has added steps to the pipeline review and approval processes (Tasker, 2016; McCarthy, 2016).

(Kasperson, Renn, Slovic, Brown, & Emel, 1988; Kasperson & Kasperson, The Social Amplification and Attenuation of Risk, 1996)

Chapter 3 Method

3.1 Data Sources

Relevant publicly available survey data are analyzed to identify patterns of perceived risks of energy pipelines, which are then compared with literatures. The surveys are conducted in 2015 and 2016 in Canada and separate gender, age, region, and political groups.

For this project, three sets of survey data are analyzed.

- **EKOS:** The survey *Canadian Attitudes toward Energy and Pipelines* commissioned by CBC and conducted by EKOS Research Associates in 2016 provides the most comprehensive set of data about Canadians' views on energy, economy, and environment and perceived risks of energy pipelines and other methods of oil transport. The EKOS survey is the only survey that answers the following questions:
    - *How safe do you think each of the following are to transport oil long distances?* (The methods of oil transport include pipelines, rails, boats, and trucks.)
    - *Would you say very safe, somewhat safe, not very safe, or not at all safe?*

  The survey questions provide information about the public's opinions on the pipeline versus rail debate as well as concerns about tankers off the West Coast.

  The results are based on a random sample of 2,098 Canadian adults aged 18 and over who have responded between February 16 and 26, 2016. A random sample of panelists has been invited to complete the survey from a representative panel of Canadians. Data are weighted by age, gender, and region according to Census data so that the composition of the sample reflects that of the composition of the Canadian population. The margin of error is plus or minus 2.1 per cent at a 95 per cent level of confidence. The margin of error increases when the results are sub-divided (i.e. gender, age, and region). (EKOS, 2016)

- **Abacus:** The survey *What keeps us awake: Top national issues* conducted by Abacus Data in 2016 provides data about Canadians' views on energy, economy, and environment, which are topics related to the debate about energy pipelines in Canada. The results are based on a random sample of 2,200 Canadian adults aged 18 and over who have responded between November 11 and 13, 2016. A random sample of panelists has been invited to complete the survey from a representative panel of over 500,000 Canadians. Data are weighted by age, gender, region, and educational attainment according to Census data so that the composition of the sample reflects that of the composition of the Canadian population. The margin of error is plus or minus 2.1 per cent at a 95 per cent level of confidence. (Anderson & Coletto, 2016)
- **CBC:** The survey *What issue is most important to you in this election?* conducted by Vote Compass in during the 2015 federal election campaign provides data about Canadians' views on energy, economy, and environment, which are topics related to the debate about energy pipelines in Canada. Vote Compass is "a civic engagement application offered in Canada exclusively by CBC News" developed by Vox Pop Labs. The results are based on 164,704 Canadian adults aged 18 and over who have responded between August 29 and September 1, 2015. Unlike the EKOS and Abacus surveys, respondents to Vote Compass are not preselected (i.e. they opt themselves in). Data are weighted by age, gender, region, educational attainment, occupation, religion, religiosity and civic engagement according to Census data so that the composition of the sample reflects that of the composition of the Canadian population. (CBC, 2015)

It is important to note that the data were weighted according to Census data so that the composition of the sample reflects that of the composition of the general Canadian population; therefore, the data are not representative of specific individuals or communities along pipelines. Additionally, the data reflect the time when the surveys were conducted. Nevertheless, the purpose of this analysis is to demonstrate whether survey results can be explained by risk perception theories and, therefore, to demonstrate whether the risk perceptions, attitudes, judgements, and behaviors are predictable.

3.2 Methods

Publicly available survey data available online are downloaded and saved. The data are reorganized, tabulated (see Appendix A), graphed, and analyzed to answer the following questions. Answering these questions is to gain a general understanding of factors affecting perceptions, attitudes, judgments, and behaviors regarding the risks of energy pipelines as well as to see how the data fit the risk perception theories in literature. If the data for the perceived risks of energy pipelines fit the risk perception theories in literature, strategies to manage the risk perception gaps of energy pipelines can be developed based on literature.

- **What is the most important issue? (The economy or the environment?)**

  There are three main pillars of sustainability: economy, environment, and society (Beattie, 2015). The use of the term "pillars" implies that all three issues equally important. The survey data can reveal whether the public perceives economic and environmental issues as equally important or one category of issues is more important than the other. The answer to this question frames the context of perceived risks of energy pipelines in terms of what matters most to the general public – the economy or the environment.

- **How do gender, age, region, and political allegiance affect perceived risks of energy pipelines?**

  As discussed, gender, age, region, and world views affect risk perceptions, attitudes, judgements, and behaviors. Research shows that men generally perceive lower risks compared to women because of different traditional gender roles, socialization, and value orientations. Additionally, younger people are generally less interested in working in the oil and gas industry and perceive the industry more negatively compared to older people. Also, research shows that location influences perception and acceptance of the risk of an activity or technology based on familiarity, economic benefits, and shared world views. If the literature findings are true for the perceived safety risks of pipelines, the survey data would show the following patterns of perceived risks of energy pipelines:

  - Men generally perceive lower risks with energy pipelines compared to women.
  - Older people generally perceive less risks with energy pipelines compared to younger people.
  - People in provinces more familiar with the oil and gas industry, such as Alberta and Saskatchewan, generally perceive lower risks with energy pipelines compared to people in provinces less familiar with the oil and gas industry.
  - People who perceive lower risks with energy pipelines generally are more individualistic compared to people who perceive higher risks with energy pipelines, who are more egalitarian. Based on the descriptions of different patterns of social relations in the Cultural Theory, those that have more individualistic views regarding energy, economic, and environmental issues are

likely to support more right-wing political parties, and those that have more egalitarian views regarding energy, economic, and environmental issues are likely to support more left-wing political parties.

- **Do signals from recent, memorable events that involve oil transport affect the public's risk perceptions of oil transport?**

An incident or a near hit involving an activity or a technology that is perceived as relatively more dread and more unknown is "a warning signal for society, providing new information about the probability that similar or even more destructive mishaps might occur within this type of activity" (Slovic, Perception of Risk, 1987). The public's memories of past events and ability to imagine future events influence risk perceptions, attitudes, judgments, and behaviors (Muhlbauer, 2004). As discussed, there has been no pipeline fail that has caused fatalities in Canada, but there has been an incident that involved rail transport of oil that caused fatalities. The Lac-Mégantic incident killed 47 people; destroyed 40 buildings, 53 vehicles, and railway tracks; and released about 100,000 litres of crude oil to the environment of downtown Lac-Mégantic, the Mégantic Lake, and the Chaudière River in 2013 (TSB, 2014). The Lac-Mégantic accident, which involves a high-speed train carrying explosive chemicals near a city, is a high-signal event (Slovic, Perception of Risk, 1987; Kraus & Slovic, 1988). The Lac-Mégantic accident can be used to answer this question, which can help quantify the effects on the perceived safety risks of oil transport after a high-signal potential risk event. If the literature findings are true for the perceived safety risks of pipelines, the survey data would show that people in Quebec, who are most closely affected by the Lac-Mégantic accident, generally perceive more risks with oil transport by rail compared to people in other provinces.

- **How do the public's risk perceptions of different methods of energy transport compare with each other and with actual safety performance measures?**

  The industry and regulators claim that pipeline transport is the safest and most efficient method to transport large volumes of oil over long distances, and that rail is not as safe as pipelines (CEPA, 2015; CEPA, 2016a; NEB, 2017a). It is argued that, without new pipeline capacity, more oil will be transported by rail. In terms of volume spilled versus transported, the pipeline industry claims safety record of 99.999 per cent (CEPA, 2016b), and the rail industry claims a safety record of 99.998 per cent (Wyman, 2015). Additionally, tanker ship transport, with only one spill in 1970 in Canadian waters (and zero spill in the West Coast), has lower spill rates than pipelines and trains (Frittelli , Andrews, Parfomak, Pirog, Ramseur, & Ratner, 2014; Transport Canada, 2016). However, it is unclear how the perceived safety risks of different methods compare relative to each other. Answering this question can help quantitatively compare on the relative perceived safety risks of different methods of oil transport.

It is not possible to directly compare the results of different surveys because of the different ways the survey questions are asked, the time when the survey questions are asked, the completeness of the data, and the ways data are presented. Additionally, actions of manually searching and sorting of data are unideal because of possibilities of subjectivity and errors. Nonetheless, the method still provides valid general results for this project, which is based on general trends and patterns rather than detailed analyses of the data.

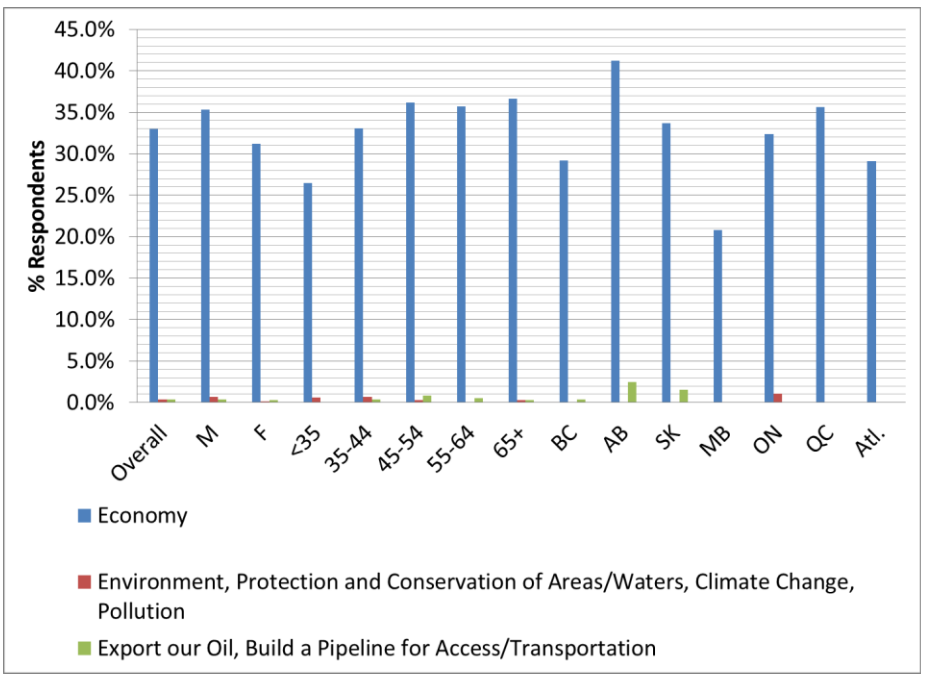
Chapter 4 Results

This section accomplishes the following:

- analyzes the surveys data about energy pipelines, environment, and the economy;
- explains interprets, discusses, and compares the results to the research question;
- links the results to previously mentioned literature; and
- explains the similarities and/or differences to past research.

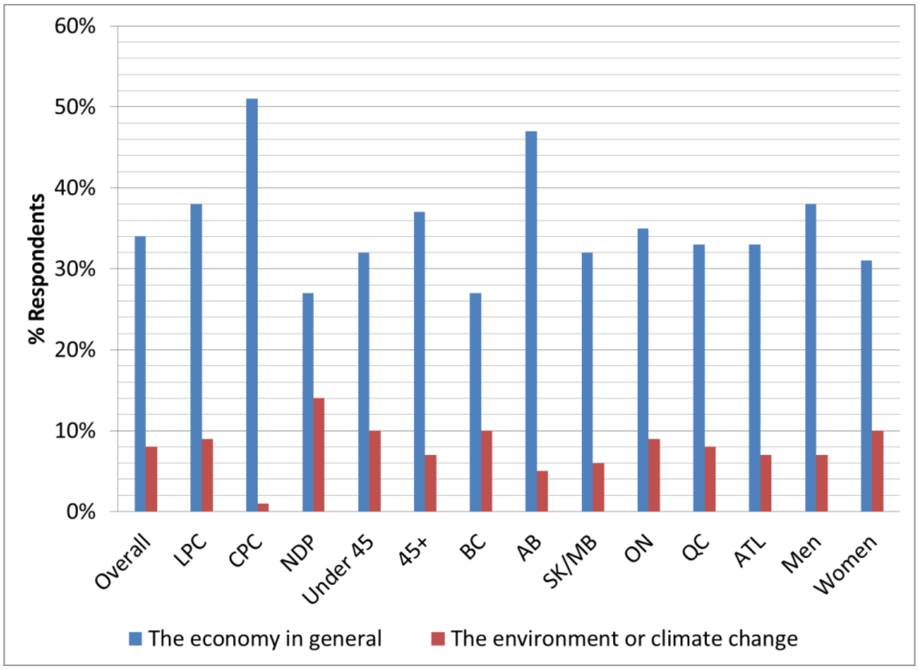
The following graphs in Figures 4 to 9 to are generated for the analysis. The tables used to generate these graphs are shown in Appendix A.

Figure 4: Economy and Pipelines versus Environment as the Top Issue in Canada by Gender, Age, and Province (EKOS Data)



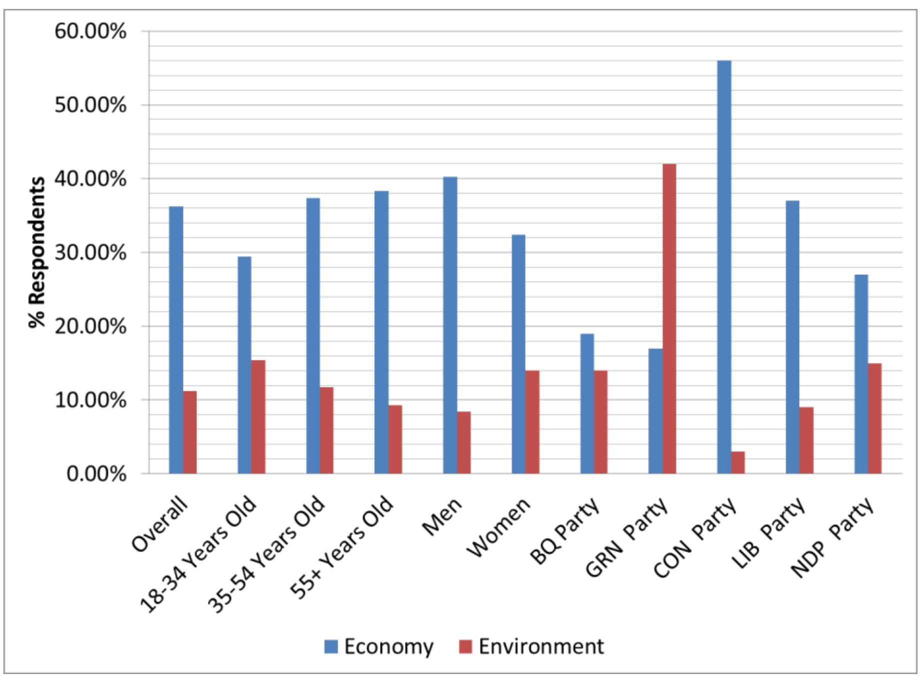
(EKOS, 2016)

Figure 5: Economy versus Environment as the Top Issue in Canada by Gender, Age, Province, and Political Allegiance (Abacus Data)



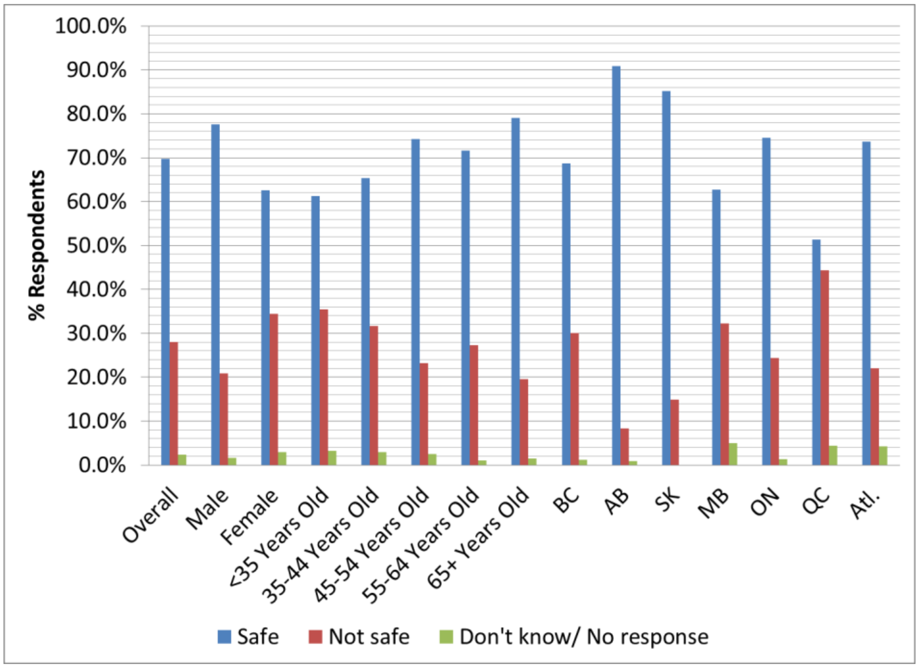
(Anderson & Coletto, 2016)

Figure 6: Economy versus Environment as the Top Issue in Canada by Gender, Age, and Political Allegiance (CBC Data)



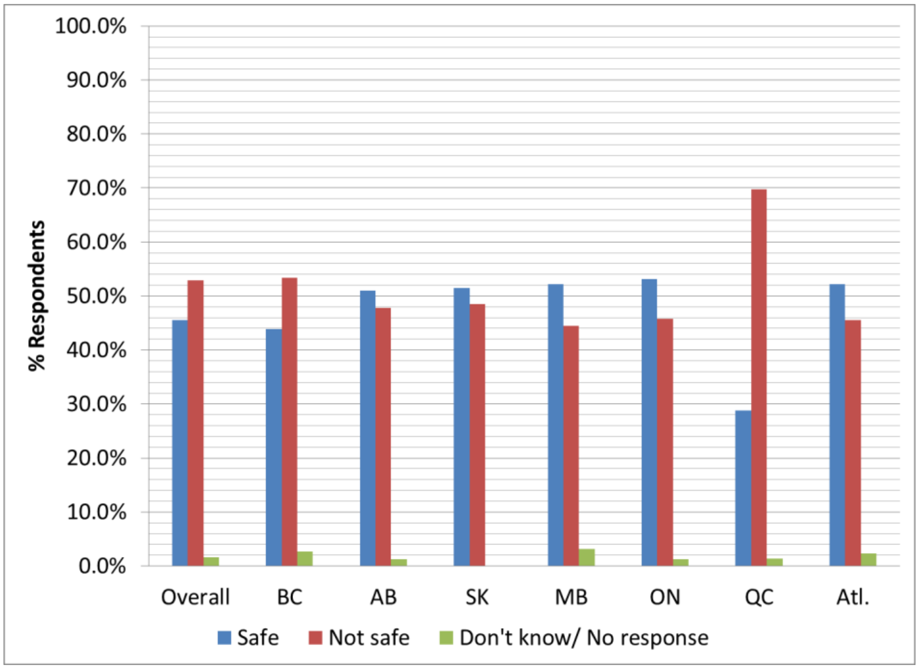
(CBC, 2015)

Figure 7: Perceived Safety of Oil Transport by Pipelines by Gender, Age, and Province



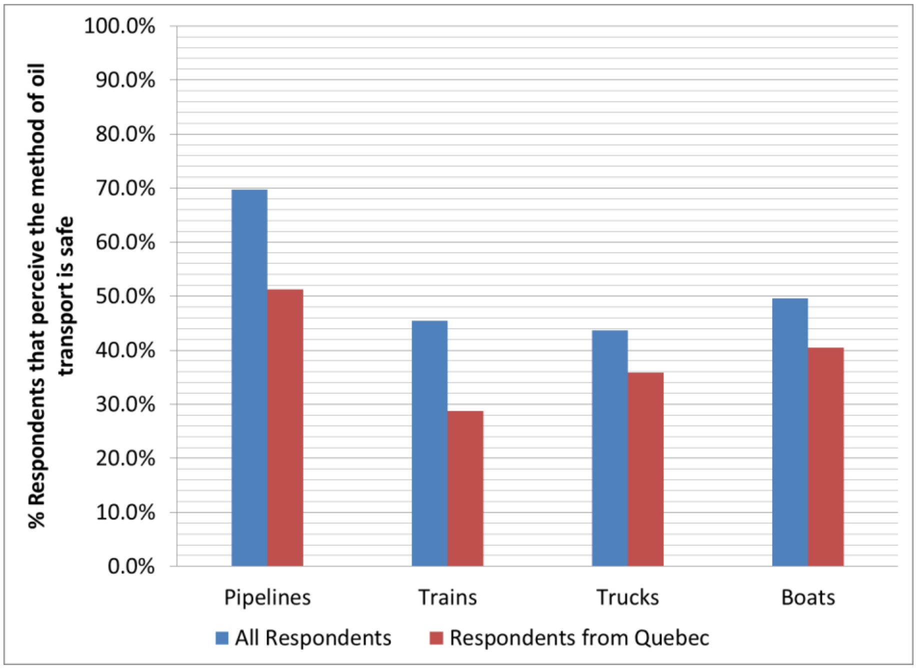
(EKOS, 2016)

Figure 8: Perceived Safety of Oil Transport by Trains by Province



(EKOS, 2016)

Figure 9: Perceived Safety of Different Methods of Oil Transport (Quebec versus All of Canada)



(EKOS, 2016)

4.1 Analysis

- **What is the most important issue? (The economy or the environment?)**

Results (Figure 4, Figure 5, and Figure 6) indicate that the Canadian public is generally more concerned about the economy than the environment. The datasets separate the economy with other economic issues like employment; therefore, if the economy and other economic issues are combined, the environment would be an even smaller issue relative to the economy. However, the survey questions are designed such that people must choose between the economy and environment and do not reflect the idea of sustainability, which integrates economic, environmental, and social considerations. Indeed, one can argue that a healthy environment provides a foundation for a healthy economy and society, and a healthy economy provides financial resources to maintain a healthy environment and society.

- **How do gender, age, region, and political allegiance affect perceived risks of energy pipelines?**

  The results suggest that gender, age, region, and world view (represented by political allegiance) affect perceived risks of energy pipelines. The results also suggest that a higher concern for the economy correlates with a lower concern for the environment and more support for energy pipeline developments in oil sands producing provinces.

  - **Gender:** Results (Figure 4, Figure 5, and Figure 6) indicate that men are more likely to perceive the economy as a more important issue than the environment compared to women. Additionally, results (Figure 7) indicate that men are more likely to perceive pipeline transport as safe compared to women. The results are consistent with research findings that suggest men generally perceive lower risks, including environmental risks, and are more concerned about the economy compared to women (Slovic, Trust, Emotion, Sex, Politics, and Science: Surveying the Risk-Assessment Battlefield, 1999; Zelezny, Chua, & Aldrich, 2000; Morioka, 2014).

  - **Age:** Results (Figure 4, Figure 5, and Figure 6) indicate that people aged 35-year old and above are more likely to perceive the economy as a more important issue than the environment compared to people aged 18 to 34-year old. Additionally, results (Figure 4) indicate that people aged 35-year old and above are more likely to perceive exporting oil and building a pipeline for access as the most important issue compared to people aged 18 to 34-year old. Also, results (Figure 7) indicate that people aged 35-year old and above are more likely to perceive pipeline transport as safe compared to people aged 18 to 34-year old. The results are consistent with the research findings that suggest younger people generally perceive the oil and gas industry more negatively compared to older people (Hussain, 2013; EY, 2017).

- **Region:** Results (Figure 4 and Figure 5) indicate that people in Alberta, Saskatchewan, Ontario, and Atlantic Canada are more likely to perceive pipeline transport as safe compared to people in British Columbia, Manitoba, and Quebec. Additionally, results (Figure 4) indicate that people in oil sands production regions (i.e. Alberta and Saskatchewan) are more likely to perceive exporting oil and building a pipeline for access as the most important issue than people in other regions. Alberta, Saskatchewan, and Newfoundland and Labrador produce 96 per cent of oil in Canada (NRC, 2016c), and Ontario manufactures much of the machinery for oil and gas development in Canada (Kline, 2013). The results are consistent with the research findings that suggest location, economic benefits, and familiarity influence acceptance of risks of an activity or a technology (Slovic, Perception of Risk, 1987; UWE, 2014; EKOS, 2016).
- **Political allegiance:** Results (Figure 5 and Figure 6) indicates that supporters of more right-wing political parties are more likely to perceive the economy as a more important issue than the environment compared supporters of more left-wing political parties. Results (Figure 6) shows that Conservative Party supporters and Green Party supporters have opposite attitudes towards economic and environmental issues. Conservative Party supporters are most likely to

perceive the economy rather than the environment as the more important issue, whereas Green Party supporters are most likely to perceive the environment rather than the environment as the more important issue.

Alberta and Saskatchewan, which are oil sands producing provinces, have mostly supported the Conservative Party in the 2015 federal election (CBC, 2015). Results (Figure 4 and Figure 7) indicate that people Alberta and Saskatchewan are more likely to perceive pipeline transport as safe and to perceive exporting oil and building a pipeline for access as the most important issue compared to people in other provinces. The findings support that the individualist's and egalitarian's world views are applicable to risk perception and risk acceptance regarding environment issues like pipelines (Ellis & Thompson, 1997).

- **Do signals from recent, memorable events that involve oil transport affect the public's risk perceptions of oil transport?**

As discussed, there has been no pipeline fail that has caused fatalities in Canada, but there has been an incident that involved rail transport of oil that caused fatalities in Lac-Mégantic, Quebec in 2013. The Lac-Mégantic accident, which involves a high-speed train carrying explosive chemicals near a city, is a high-signal event (Slovic, Perception of Risk, 1987; Kraus & Slovic, 1988). Results (Figure 8) indicate that people in Quebec are more likely to more likely to perceive rail transport as unsafe compared to people in other provinces. Additionally, results (Figure 9) indicate that people in Quebec perceive rail transport is the least safe method of oil transport compared to other methods of oil transport. According to the survey results, while 52.9 per cent of all respondents perceive rail as unsafe, 69.8 per cent – an overwhelming majority – of all respondents from

Quebec perceive rail as unsafe. This is despite rail, with a safety record of 99.998 per cent, is a relatively safe method of oil transport (Wyman, 2015). Also, most people in Canada perceive that rail transport is an unsafe method of oil transport. This effect of the accident in Quebec on the perceived risks of oil transport by rail across Canada can be explained with the Social Amplification of Risk framework, which suggests that a risk event in one location can affect the rest of society (Kasperson, Renn, Slovic, Brown, & Emel, 1988; Kasperson & Kasperson, The Social Amplification and Attenuation of Risk, 1996). Lastly, there are no data about the perceived risks of oil transport by rail before the Lac-Mégantic incident available, so changes of perceived risks before and after a high-signal event cannot be observed and quantified.

- **How do the public's risk perceptions of different methods of energy transport compare with each other and with actual safety performance measures?**

Results (Figure 9) suggest that, generally, people perceive pipelines as safe (i.e. more than 50 per cent people think the methods are safe) whereas boats (oil tankers), trains, and trucks as unsafe (i.e. less than 50 per cent people think the methods are safe). Therefore, the public agrees with the industry in that pipeline is the safest method to transport oil and gas. However, the results suggest that safety performance measures, which are often expressed as volume transported versus volume spilled, cannot be directly compared to risk perceptions. As discussed, the industry claims that energy pipeline transport, with a 99.999 per cent safety record based on volume transported versus volume spilled (CEPA, 2016b), but survey results indicate that just over 50 per cent of the people in Quebec perceive pipelines as safe. On the other hand, rail transport, which has a safety record of 99.998 per cent (Wyman, 2015), and tanker ship transport, with only one spill in 1970 in Canadian waters (and zero spill in the West Coast), (Frittelli , Andrews, Parfomak, Pirog, Ramseur, & Ratner, 2014; Transport Canada, 2016), have even bigger perception gaps than pipelines. The relatively high perceived risks of oil transport by trains may be caused by the public's memory of Lac-Megantic, and the relatively high perceived risks of oil transport by boats may be caused by the public's memory of Exxon Valdez in 1989 in US waters. Additionally, the higher perceived risks of all oil transport methods in Quebec when compared to those in other provinces can be partly explained by the Social Amplification of Risk, which suggests that a risk event can affect other technologies (Kasperson, Renn, Slovic, Brown, & Emel, 1988; Kasperson & Kasperson, The Social Amplification and Attenuation of Risk, 1996).

Before this research, no research has attempted to place energy pipelines in the cognitive map (Figure 1). However, the research by Kraus and Slovic (1988) has found that "a high-speed train carrying explosive chemicals near a city is perceived to be much more like hazards associated with nuclear reactors than like other railroad hazards" (Kraus & Slovic, 1988, p.453). Therefore, the research by Kraus and Slovic (1988) suggests that the concerns are mostly about the transported product (i.e. explosive chemicals like oil) rather than the mode of transport (i.e. pipeline versus rail) and that energy transport, including pipeline and rail transport, is perceived as highly risky. Additionally, the research suggests that the comparison of oil transport by pipeline and by rail may have limited effects on influencing the perceived risks of energy pipelines. For example, the molasses pipeline incident in Honolulu Harbor in 2013 killed 25,000 fish and damaged coral reefs (EPA, 2017), and the water pipeline incident in Boston in 2016 killed two people (OSHA, 2017), but there has not been prolonged widespread public outcry against molasses, water, or pipelines. Some pipelines are even celebrated, such as Halve Maan's beer pipeline, the world's first beer pipeline, that started operations in Bruges in 2016 (Reuters, 2016); yet, even a beer pipeline incident can harm people and the environment. However, it is important to note that an oil spill is more difficult to clean than a molasses, water, or a beer spill, and that oil and gas are explosive chemicals whereas molasses, water, and beer are not.

The book *Pipeline risk management manual: ideas, techniques, and resources* by Muhlbauer (2004) states that "a train wreck claiming many lives might not generate as much social response – being a more familiar and well-understood system – than a small pipeline accident, in which the system is less understood and the consequence are perceived to be less controllable and more catastrophic; hence, the more widespread public outcry from a pipeline accident" (Muhlbauer, 2004, p. 353). It is important to note that the book is published in 2004 and before the Lac-Mégantic rail in 2013, and the "train wreck" example does not specify the type of product being transported. Because the product transported is a more important factor than the method of transport, if the Lac-Mégantic incident has involved a pipeline rather than a train, it is not inconceivable for perceived risks of energy pipelines to be higher than that of trains.

4.2 Findings

The analysis of the survey data suggests that the perceived risks of energy pipelines are not independent from factors like the economy, the environment, gender, age, region, world view (i.e. political allegiance), psychological effects of past high-signal events, and amplification. The analysis of the survey data also indicates that the patterns of the perceived risks of energy pipelines can be explained by risk perception research. This is significant because the public's perceptions, attitudes, judgements, and behaviors regarding the risks of energy pipelines can be predicted. Specifically, the results of the analysis suggest the following:

- The Canadian public is generally more concerned about the economy than the environment. However, the survey questions are designed such that people must choose between the economy and environment and do not reflect the idea of sustainability, which integrates economic, environmental, and social considerations.
- Men are more likely to perceive the economy as a more important issue than the environment and to perceive pipeline transport as safe compared to women.
- People aged 35-year old and above are more likely to perceive the economy as a more important issue than the environment and more likely to perceive pipeline transport as safe compared to people aged 18 to 34-year old. Additionally, people aged 35-year old and above are more likely to perceive exporting oil and building a pipeline for access as the most important issue compared to people aged 18 to 34-year old.
- People in oil sands producing provinces are more likely to have individualistic political ideologies regarding energy, the economy, and the environment compared to people not in oil sands producing provinces. They are more likely to perceive pipeline transport as safe and to perceive exporting oil and building a pipeline for access as the most important issue compared to people in other provinces. This can be explained by higher familiarity and perceived benefits with energy development as well as the individualistic world view that perceives nature is “benign and resilient” and “able to recover from any exploitation” (i.e. “can take anything we throw at her”) (Carnegie Council, 2000; Thompson, 2000, p. 2).

- People not in oil sands producing provinces are more likely to have egalitarian political ideologies regarding energy, the economy, and the environment compared to people in oil sands producing provinces. They are less likely to perceive pipeline transport as safe and to perceive exporting oil and building a pipeline for access as the most important issue compared to people in oil sands producing provinces. This can be explained by lower familiarity and perceived benefits with energy development as well as the egalitarian world view that perceives nature is "fragile, intricately interconnected and ephemera" (Carnegie Council, 2000; Thompson, 2000, p. 2).
- The effects of a memorable event on the public's risk perceptions can be quantified. After the Lac-Mégantic incident, people in Quebec perceive that rail transport is the least safe method of oil transport compared to other methods of oil transport. Also, most people in Canada perceive that rail transport is an unsafe method of oil transport, and this can be explained with the Social Amplification of Risk framework, which suggests that a risk event in one location can affect the rest of society (Kasperson, Renn, Slovic, Brown, & Emel, 1988; Kasperson & Kasperson, The Social Amplification and Attenuation of Risk, 1996).

4.3 Discussion

The analysis and findings are compared with research questions to provide context and to develop strategies for better managing the perceived risks of energy pipelines.

This project attempts to answer the following research questions:

1) Is there a risk perception gap regarding the safety of energy pipelines?

2) How can the gap be closed if there is one?

1) Is there a risk perception gap regarding the safety of energy pipelines?

On the surface, the comparison of safety records and survey data suggests that there is a perception gap regarding the risks of energy pipelines, but the gap exists because technical risk assessments and statistics do not represent the entire context of the risks involved. Indeed, a safety record of 99.999 per cent volume transported versus volume spilled does not mean that 99.999 per cent of the public perceive pipelines as safe. As psychometric research suggests, concerns about risks are not only about technical risk statistics and performance measures but also about people's intuitive heuristics and cognition; therefore, pipeline safety statistics and survey data are not directly comparable. As the paper *Perception of Risk* by Slovic (1987) states, "[p]eople's perceptions and attitudes are determined not only by…statistics…but also by the variety of quantitative and qualitative characteristics reflected in [dread and unknown factors in the cognitive map]" (Slovic, 1987, p. 285).

Additionally, the data analysis suggests that risks of energy pipelines are perceived differently by different groups (i.e. separated by gender, age, region, and political allegiance) and are associated with disagreements over prioritizing economic versus environmental issues. Sociological and anthropological research suggests that some of the concerns about pipeline safety are not even be about the risks; rather, the concerns about pipeline safety justify actions for other social or ideological concerns (Slovic, Perception of Risk, 1987). (i.e. There is a gap between ideologies.) For pipelines, concerns about risks provide a platform for the debate about energy and economic development versus local environmental protection and global climate change. According to the Cultural Theory, people's world views, way of life, ideologies, deeply held values, and beliefs determine "what to fear…and how much to fear it" (Wildavsky & Dake, 1990, p. 22), and individuals perceive activities and technologies that endanger their way of life as risky, so a low risk does not necessary mean the risk is accepted (Wildavsky & Dake, 1990; Oltedal, Moen, Klempe, & Rundmo, 2004). In the EKOS survey, respondents answers whether they perceive pipelines as “safe” or “unsafe”, but the responses not differentiate whether the respondents’ answers are driven by psychological reasons (i.e. dread or unknown factors) or ideological (i.e. sociocultural) reasons. It is entirely possible that a respondent perceives that pipelines are safe, but because the respondent does not support fossil fuels, the respondent answers that pipelines are “unsafe”. The research by Ellis and Thompson (1997) has found that the individualist’s and egalitarian’s world views are most applicable to risk perceptions regarding environment issues like pipelines (Ellis & Thompson, 1997), and their world views are almost opposite of each other regarding nature. Therefore, additionally to people’s intuitive heuristics and cognition, people’s priorities (i.e. what matters most to people) also play a factor in the perceived safety risks of pipelines.

Psychological and sociocultural factors on risk perceptions illustrate the importance of non-technical contexts of risk. Comparing technical risk assessments and statistics and the public’s risk perceptions can lead to a narrow focus on the different expertise and knowledge while overlooking the contexts and values about the risks involved.

2) How can the gap be closed if there is one?

As discussed above, risk perception gaps exist for the risks of energy pipelines because technical risk assessments and statistics do not represent the contexts about the risks involved. Based on literature review and data analysis, it is found that the risk perception gap of energy pipelines can be managed by applying the following strategies:

- **Improving perceived benefit distribution:** Literature review and data analysis suggest that, generally, people that are directly benefiting from oil and gas development are more likely to accept the risks of pipeline transport. When risks are perceived as dread, catastrophic, uncontrollable, difficult to decrease, and increasing, a potential way to improve risk acceptability is improving equity (i.e. increasing benefit distribution). As the analysis have suggested, people generally perceive the economy as a more important issue than environment; therefore, companies and the industry must clearly demonstrate to the public that the economic benefits exceed the environmental risks.

However, the strategy of improving risk acceptability by increasing benefit distribution should be executed with careful tactics. Cultural Theory research suggests that world views, ideologies, deeply held values, and beliefs determine "what to fear" (Wildavsky & Dake, 1990). The research by Cleland et at. (2016) suggests that, in some cases, negotiable economic factors like jobs and community investment are less important compared to deeply held values like environment, tradition, openness, and fairness, and that speaking to economic benefits alone will not change people from their values (Cleland, Bird, Fast, Sajid, & Simard, 2016).

- **Improving familiarity:** Literature review and data analysis suggest that a lack of familiarity of pipelines increases the level of perceived risks of pipelines. Therefore, improving the public's familiarity about pipelines may improve the public's perceived risks of energy pipelines. Increasingly, companies, industry associations, and regulators are engaging the public and sharing information with the public via mediums like corporate social responsibility reports, industry safety performance reports, and free access to the pipeline safety standard *CAN/CSA-Z662-15 - Oil and gas pipeline system* (NEB, 2017b). However, the effectiveness of these initiatives needs to be monitored because risk perception research indicates that disagreements about risk are not always resolved with additional information (Slovic, Perception of Risk, 1987).

- **Acknowledging and accommodating the public's different world views:** In a new energy pipeline development projects, the public may oppose risk decisions that are forced on them by experts and governmental authorities and demand bigger roles in making decisions that affect them economically, environmentally, and socially (Rippl, 2002; Cleland, Bird, Fast, Sajid, & Simard, 2016). Additionally, the proponet should acknowledge that communities may have different world views, and these communities should be consulted and accommodated. This may involve changing parts of the project to accommodate the communities. However, the proponet should also be open to the possibility that local values and broader societal interests may be irreconcilable regardless of the extent of consultation and accommodation (Cleland, Bird, Fast, Sajid, & Simard, 2016). For proposed energy pipelines that cross cross long distances and come across many different communities with different risk perceptions, attitudes, and world views, more resources and time may be required for negotiation.

  Additionally, influential environmental and social activist groups that can make a pipeline company or a proposed project a target are stakeholders that should be monitored and engaged. The company may be skeptical about whether activist groups are genuinely interested in collaborating, but the existence of activist groups, which represent different world views, is a fact of life (and a source of non-technical risks), and the company should engage these groups to better identify and address issues. (Eccles, Newquist, & Schatz, 2007)

- **Systematically managing perceptions in the media:** The Social Amplification of Risk framework by Kasperson et al. (1988) and Kasperson and Kasperson (1996) provides a comprehensive framework that unites technical factors; psychological and sociocultural factors; institutional factors; and communication to explain the public's processing of information about a risk. This framework also highlights the significant role of the media in influencing the public's risk perceptions, attitudes, judgement, and behaviors and triggering ripple effects with far reaching impacts on the company, the industry, other technologies, and the society. (Kasperson, Renn, Slovic, Brown, & Emel, 1988; Kasperson & Kasperson, The Social Amplification and Attenuation of Risk, 1996)

  The media plays a significant role in amplifying and attenuating risk perceptions. Although maintaining good safety performance is important for maintaining a good perception, managing the discussions in the media is just as important. The strategy for managing perceptions in the media is based on the research on strategic media intelligence by Eccles et al (2007).

  A pipeline company should begin by performing a baseline assessment of the media coverage of energy pipelines. This includes coverage of the company and its peers and risk events like routine or unexpected releases of products, accidents (minor and major), pollution, exposures, adverse consequences, or near hits. A risk event may also be a release of a new government or public interest group report about pipeline safety. The media coverage of a risk event should be assessed for the extent of influence on the public's risk perceptions and behaviors and the potential for triggering ripple effects with far reaching impacts on the company, the industry, other technologies, and society. Coverage of risk events of related methods of oil and gas transport and the oil and gas industry in general may also affect the perceived risks of energy pipelines. Techniques for evaluating the perceived risks of energy pipelines include media analysis, clipping services, strategic media intelligence, surveys, and focus groups (Eccles, Newquist, & Schatz, 2007).

The volume and tone of media coverage set the agenda; therefore, a company should maintain a minimum number of stories about itself in the media, and the coverage is positive overall. According to the research by the Media Tenor Institute for Media Analysis, a positive reputation requires that at least 20 per cent of the stories in the media be positive, at most 10 per cent negative, and the rest neutral and at least a 35 per cent of the information is given by company during normal times and 50 per cent during a crisis like a pipeline failure (Eccles, Newquist, & Schatz, 2007). In contrast, the overall coverage has been unfavorable to the energy pipeline industry. The volume of stories related to pipeline development projects, including Keystone XL and Northern Gateway, has increased by 450 per cent in between 2009 and 2013, and a fifth of them are positive in tone while a third of the stories are negative in tone (Cano, 2013). The increased volume and negative tone of the coverage is likely a contributing factor to the poor perceived risks of energy pipelines in parts of Canada that are less familiar with the energy industry. Continual efforts to engage the public and to share information with the public via mediums like corporate social responsibility reports and industry safety performance reports may help pipeline companies reposition themselves in the media. However, the effectiveness of these initiatives needs to be monitored because risk perception research indicates that disagreements about risk are not always resolved with additional information (Slovic, Perception of Risk, 1987). Nonetheless, at the minimum, pipeline companies are able to better manage the proportion of negative stories in the media.

The company should also evaluate its ability to meet the performance expectations of stakeholders (Eccles, Newquist, & Schatz, 2007). For energy pipeline transport, the goal is zero pipeline incidents (CEPA, 2007). It is important to remember that managing perceived risks is closely connected to managing the technical safety risks because the Social Amplification of Risk begins with a risk event like a pipeline failure (Kasperson, Renn, Slovic, Brown, & Emel, 1988; Kasperson & Kasperson, The Social Amplification and Attenuation of Risk, 1996).

When a company has evaluated the public's perception of the risks of energy pipelines and its ability to meet performance expectations, it decides whether the perception exceeds reality or vice versa. If reality exceeds perception, the perception gap can be closed with a more effective corporate communications program as discussed above. If a perception exceeds reality, performance should be improved or perceptions should be moderated. For energy pipeline transport, the goal is zero pipeline incidents (CEPA, 2007), and pipeline companies should evaluate their abilities to meet the performance expectations. Indeed, energy pipeline transport, which already has safety records of zero serious public injuries and fatalities caused by a rupture in more than 60 years and 99.999 per cent volume transported versus spilled, is a relatively safe way to transport oil and gas (CEPA, 2015; CEPA, 2016a). The goal of zero incident may be difficult to meet. However, people may acknowledge that the risks of energy pipelines are low but may still do not accept the risks for other social or ideological reasons such as the opposition to oil and gas consumption and production. In this case, Slovic (1987) suggests that “communication about risk is simply irrelevant…[and]…[h]idden agendas need to be brought to the surface for discussion” (Slovic, Perception of Risk, 1987), and additional consultation, accommodation, and collaboration based on world views may be needed (see Consultation, Accommodation, and Collaboration).

Lastly, strategic risk perception management is a continual activity. Media coverage should be continually monitored and reassessed because risk perceptions, attitudes, judgments, and behaviors evolve as economic, environmental, social, technological, and political trends change.

Chapter 5 Conclusion

Research on perceived risks of energy pipelines is important because the public's risk perceptions, attitudes, behaviors, and judgements can significantly impact energy pipeline projects; therefore, risk perception is a significant source of non-technical risks, which account for about 70 to 75 per cent of cost and schedule failures in oil and gas projects (Brewer & McKeeman, 2012; Esteves, 2015; Valiant Business Media, 2015). Understanding risk perception helps with understanding the public's concerns at a fundamental level and can be useful for energy pipeline development project proponents in achieving agreements with involved parties. The findings of this project suggest that perceived risks of energy pipelines have are real risks to energy pipeline projects; therefore, understanding and managing risk perceptions can help decrease costs, delays, frustration, and conflicts.

1) Is there a risk perception gap regarding the safety of energy pipelines?

On the surface, the comparison of safety records and survey data suggests that there is a perception gap regarding the risks of energy pipelines, but the gap exists because technical risk assessments and statistics do not represent the entire context of the risks involved. Indeed, a safety record of 99.999 per cent volume transported versus volume spilled does not mean that 99.999 per cent of the public perceive pipelines as safe. As psychometric research suggests, concerns about risks are not only about technical risk statistics and performance measures but also about people's intuitive heuristics and cognition; therefore, pipeline safety statistics and survey data are not directly comparable. Additionally, sociological and anthropological research suggests that some of the concerns about pipeline safety are not even be about the risks; rather, the concerns about pipeline safety justify actions for other social or ideological concerns (Slovic, Perception of Risk, 1987). (i.e. There is a gap between ideologies.) For pipelines, concerns about risks provide a platform for the debate about energy and economic development versus local environmental protection and global climate change.

2) How can the gap be closed if there is one?

As discussed above, risk perception gaps exist for the risks of energy pipelines because technical risk assessments and statistics do not represent the contexts about the risks involved. Based on literature review and data analysis, it is found that the risk perception gap of energy pipelines can be managed by applying the following strategies:

- Improving perceived benefit distribution
- Improving familiarity
- Acknowledging and accommodating the public's different world views
- Systematically managing perceptions in the media

In Canada, when it comes to energy pipelines, there is a lot at stake. Pipeline development would not be so contentious if it did not have significant potential economic benefits and risks to people and the environment. Perhaps the most important realization from this project is that excluding the public's concerns in technical risk assessments and decision-making causes the apparent risk perception gap regarding the safety of energy pipelines. The public lacks certain technical knowledge about energy pipelines, but the public's concerns and priorities are nonetheless legitimate although are typically excluded from technical risk assessments and decision-making. Therefore, risk management should be a collaborative process that involves the experts and the public and recognizes the full context of risk, especially when under the intense scrutiny of the media. This requires more openness, transparency, and trust among the parties involved.

5.1 Limitations and Future Research

The following future research can help better understand and manage the perceived risks of energy pipelines.

- **Validating risk perception theories regarding energy pipelines**

  This project was executed based on a review of academic literatures and analysis of survey data. Consulting practitioners of risk assessment, communication, and engagement in the energy pipeline industry for their perspectives on risk perceptions can help validate the results and may identify factors unique to energy pipelines.

- **Separating natural gas pipelines and crude oil pipelines**

  The project studies the perceived risks of energy pipelines. However, it is possible that the public perceives the risks of natural gas pipelines and crude oil pipelines differently. The research by Kraus and Slovic (1988) suggests that the concerns are mostly about the transported product (Kraus & Slovic, 1988). In certain situations, the technical mechanisms of a gas pipeline failure are different than those of a liquid pipeline failure. Additionally, the consequences are different in nature. If a gas pipeline ruptures in a high population density area, the consequences are serious injuries and fatalities caused by thermal effects. If an oil pipeline ruptures in an environmentally sensitive area, the consequences are contamination of drinking water, vegetation, and fish.

- **Addressing the public's concerns about the high consequences**

  The literature review and data analysis suggest that the public is concerned about the high stakes associated with the consequences and uncertainties of a pipeline incident and is not comforted by the low probability of a pipeline failure (Aven & Renn, 2009). Presently, companies and the industry mainly communicate the low probability of a pipeline incident as a part of their communication strategies; however, improving how the public's concerns about the potential high consequences of a pipeline failure are addressed may reduce the levels of the perceived safety risk of a pipeline. Further research into managing the public's concerns about the high consequences of a pipeline incident would be useful.

- **Developing processes and procedures to manage perceived risks**

  This report provides a high-level overview of risk perception theories and connects these theories to data analysis. The strategies to close the perception gap can be incorporated into existing risk management processes and procedures. These processes and procedures should be reviewed and maintained following a plan-do-check-act cycle of continual improvement.

- **Reviewing current practices and tracking changes to risk perception over time**

  Pipeline companies and the industry are increasingly investing in corporate social responsibility (CSR), communication, and engagement initiatives, and it is important to demonstrate whether these initiatives are effective in managing risk perceptions. When strategies for managing perceived risks of pipelines are developed and executed, surveys and strategic media intelligence can be used for continually assessing perceived risks of pipelines as part of the overall risk management system. Survey data can then be analyzed to evaluate the effectiveness of the strategies for managing risk perceptions of pipelines. Quantifiable data for assessing risk perceptions should be collected, managed, and analyzed periodically to identify changing patterns over time.

- **Tracking changes to risk perceptions before and after a catastrophic accident**

  For this research project, no data that indicate changes to risk perceptions before and after a catastrophic accident are available for analysis. It would be useful to consistently track risk perceptions of activities and technologies over time to quantify changes to the risk perceptions after a high-signal incident. This information can provide insights into repairing risk perception after a high-signal incident.

- **Survey questions should be open to the idea of sustainability that integrates economic and environmental (as well as social) issues**

  The datasets used for this project separate economic issues form environment issues and do not reflect the idea of sustainability, which integrates economic, environmental, and social considerations. The reality is rarely black and white, and future surveys should better reflect the public's attitudes and judgements on balancing economic, environmental, and social issues. Indeed, one can argue that a healthy environment provides a foundation for a healthy economy and society, and a healthy economy provides financial resources to maintain a healthy environment and society.

- **Survey questions should differential concerns based on psychological or ideological reasons**

  In the EKOS survey, respondents answers whether they perceive pipelines as "safe" or "unsafe", but the responses not differentiate whether the respondents' answers are driven by psychological reasons (i.e. dread or unknown factors) or ideological (i.e. sociocultural) reasons. For pipelines, concerns about risks provide a platform for the debate about energy and economic development versus local environmental protection and global climate change. According to the Cultural Theory, people's world views, way of life, ideologies, deeply held values, and beliefs determine "what to fear…and how much to fear it" (Wildavsky & Dake, 1990, p. 22), and individuals perceive activities and technologies that endanger their way of life as risky, so a low risk does not necessary mean the risk is accepted (Wildavsky & Dake, 1990; Oltedal, Moen, Klempe, & Rundmo, 2004). It is entirely possible that a respondent perceives that pipelines are safe, but because the respondent does not support fossil fuels, the respondent answers that pipelines are "unsafe". Therefore, future surveys should better differentiate whether the respondents' answers are driven by psychological reasons (i.e. dread or unknown factors) or ideological (i.e. sociocultural) reasons so that the root causes of the perceived risks can be identified and any hidden agendas can be brought to the surface for discussion.

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Appendix A Data Tables

Appendix A-1: Most Important Issues in Canada (EKOS Data)

EKOS Question "In your opinion, what is the most important issue facing Canada today?"		**Gender**		**Age**					**Region**						
	Over all	**M**	**F**	**<35**	**35-44**	**45-54**	**55-64**	**65+**	**BC**	**AB**	**SK**	**MB**	**ON**	**QC**	**Atl.**
Economy	33.0%	35.3%	31.2%	26.5%	33.1%	36.2%	35.7%	36.6%	29.2%	41.2%	33.7%	20.8%	32.4%	35.6%	29.1%
Unemployment Rates, Job Creation, Getting Canadians Working	7.7%	7.2%	8.4%	5.1%	3.4%	10.2%	9.2%	11.3%	5.4%	6.0%	2.6%	8.8%	11.3%	2.6%	14.4%
Government Spending, Debt/Deficit, Fiscal Responsibility, Need to Reduce Spending	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Health Care	4.3%	5.7%	3.0%	3.9%	5.0%	3.4%	5.1%	4.3%	3.1%	3.2%	3.8%	1.9%	4.5%	5.4%	3.8%
Senior Issues/Needs (e.g: Health Care/Supports, Housing...)	3.3%	1.5%	4.9%	3.1%	4.2%	3.8%	2.3%	3.1%	4.1%	1.3%	0.0%	2.5%	4.6%	2.4%	2.0%
Helping Those with Low Income/Lower Wage Brackets (e.g: Disabled People's Income Levels, Less Fortunate/Needy, Those in Poverty...)	0.7%	0.5%	0.9%	0.4%	1.5%	0.3%	1.2%	0.3%	0.6%	0.9%	0.0%	0.0%	0.9%	0.7%	0.0%

EKOS Question "In your opinion, what is the most important issue facing Canada today?"		Gender		Age					Region						
	Over all	M	F	<35	35-44	45-54	55-64	65+	BC	AB	SK	MB	ON	QC	Atl.
Public Infrastructure, Roads/Transit	1.4%	0.5 %	2.3 %	1.4 %	1.1 %	0.8 %	2.0 %	1.9 %	1.2 %	0.4 %	1.2 %	0.0 %	1.6 %	1.2 %	3.6 %
Environment, Protection and Conservation of Areas/Waters, Climate Change, Pollution	0.4%	0.7 %	0.1 %	0.6 %	0.7 %	0.3 %	0.0 %	0.3 %	0.0 %	0.0 %	0.0 %	0.0 %	1.1 %	0.0 %	0.0 %
Education Issues: Access/Affordability, Tuition Costs	12.1 %	10.5 %	13.8 %	16.9 %	13.5 %	10.7 %	8.3 %	8.6 %	12.6 %	4.7 %	10.6 %	18.6 %	10.9 %	17.2 %	9.5 %
Good Government/Planning, Responsible to the People/Needs of the Country, Honesty/Accountable, Stopping Corruption	3.5%	5.2 %	1.8 %	1.7 %	2.8 %	5.1 %	4.7 %	3.9 %	1.8 %	5.6 %	1.2 %	3.5 %	4.3 %	3.0 %	2.1 %
Tax Reform, Taxes too High	0.6%	0.5 %	0.8 %	0.7 %	1.1 %	1.0 %	0.3 %	0.0 %	0.6 %	0.5 %	0.0 %	1.8 %	1.1 %	0.2 %	0.0 %
Immigration Issues/Concerns, Refugees	1.7%	1.8 %	1.7 %	2.8 %	1.4 %	0.8 %	1.5 %	1.6 %	2.8 %	1.9 %	2.9 %	3.9 %	0.2 %	2.9 %	2.2 %
Housing Cost, Affordable Housing	0.7%	0.4 %	0.9 %	1.3 %	0.3 %	0.5 %	0.5 %	0.6 %	2.0 %	0.5 %	0.0 %	2.4 %	0.6 %	0.0 %	0.6 %
Need to Care for	0.9%	0.6	1.2	0.9	1.0	0.4	0.6	1.6	0.2	1.2	0.9	1.5	1.0	0.0	1.9

EKOS Question "In your opinion, what is the most important issue facing Canada today?"		Gender		Age					Region						
	Over all	M	F	<35	35-44	45-54	55-64	65+	BC	AB	SK	MB	ON	QC	Atl.
Canadians/People Here Already Before Bringing in Refugees, Take Care of Current Issues Here		%	%	%	%	%	%	%	%	%	%	%	%	%	%
First Nations/Aboriginal Issues and Concerns	1.5%	1.1 %	2.0 %	2.1 %	1.5 %	0.6 %	1.4 %	1.7 %	1.7 %	0.5 %	4.3 %	7.9 %	1.4 %	1.0 %	1.0 %
Economic/Social Equality: Middle Class Concerns/Income Disparity, Low Wages vrs. Inflation/Cost of Living/Quality of Life	4.1%	4.5 %	3.4 %	6.0 %	3.9 %	2.9 %	3.9 %	3.0 %	5.5 %	1.9 %	7.3 %	3.9 %	4.4 %	2.6 %	6.1 %
Oil/Energy Crisis, Low Oil Prices, Declines in the Oil/Fuel Industry	3.4%	3.3 %	3.5 %	2.8 %	4.6 %	1.1 %	4.7 %	4.4 %	1.6 %	9.5 %	9.5 %	0.0 %	1.9 %	3.7 %	3.3 %
Energy, Energy Strategy, Renewable Energy	0.9%	0.8 %	0.8 %	0.8 %	0.6 %	1.0 %	0.7 %	1.2 %	0.8 %	0.9 %	0.0 %	0.0 %	1.0 %	0.8 %	0.7 %
Security/Terrorism	1.4%	1.5 %	1.2 %	0.5 %	1.2 %	3.2 %	0.7 %	1.3 %	0.9 %	0.8 %	0.0 %	2.5 %	1.6 %	1.9 %	0.0 %
Islam, Islamic State, General Mention	0.6%	0.6 %	0.5 %	0.7 %	0.3 %	0.3 %	0.7 %	0.6 %	0.0 %	0.4 %	0.0 %	0.0 %	0.4 %	1.5 %	0.0 %
Participation in War/Peacekeeping	1.1%	0.9 %	1.2 %	1.2 %	1.3 %	0.0 %	1.3 %	1.7 %	0.4 %	0.7 %	0.0 %	0.0 %	0.6 %	3.0 %	0.4 %

EKOS Question "In your opinion, what is the most important issue facing Canada today?"		Gender		Age					Region						
	Over all	**M**	**F**	**<35**	**35-44**	**45-54**	**55-64**	**65+**	**BC**	**AB**	**SK**	**MB**	**ON**	**QC**	**Atl.**
Missions, Debate of Pulling Out, Foreign War/Peace Policy															
Lack of Unity/National Unity, Divisive Country	0.3%	0.5 %	0.1 %	0.5 %	0.3 %	0.3 %	0.2 %	0.0 %	0.0 %	1.2 %	0.0 %	0.0 %	0.2 %	0.2 %	0.7 %
Democracy/Human Rights (Privacy Rights, Respect for Democracy, Democratic Reform)	0.8%	1.0 %	0.6 %	0.6 %	0.8 %	1.3 %	0.6 %	0.4 %	0.0 %	0.9 %	1.2 %	0.0 %	0.8 %	1.4 %	0.0 %
Finding a Balance between Economic Needs and Environmental Sustainability, Diversify in Sustainable Methods, Tempering Exploitation of Resources/Oil with Different Markets	2.7%	2.7 %	2.6 %	2.5 %	3.1 %	3.2 %	3.1 %	2.1 %	6.7 %	4.7 %	5.4 %	7.0 %	1.3 %	1.2 %	0.0 %
Cultural Issues/Concerns, Changes/Challenges with Culture Identities with Immigration and Influx of Refugees	0.6%	0.4 %	0.6 %	0.3 %	0.9 %	0.2 %	0.5 %	1.0 %	1.5 %	0.8 %	0.0 %	0.0 %	0.3 %	0.7 %	0.0 %
Lack of Moral/Ethics/Values/Conne	0.8%	1.2 %	0.4 %	0.8 %	1.5 %	0.8 %	0.8 %	0.1 %	0.7 %	0.8 %	1.2 %	0.0 %	0.7 %	0.3 %	3.3 %

EKOS Question "In your opinion, what is the most important issue facing Canada today?"		Gender		Age						Region						
	Over all	M	F	<35	35-44	45-54	55-64	65+	BC	AB	SK	MB	ON	QC	Atl.
ction/Care in People, Misguided Values/Priorities such as Greed/Apathy															
International Relations/Perceptions, Restore World Views, Credibility	0.4%	0.3 %	0.4 %	0.4 %	0.0 %	0.6 %	0.3 %	0.5 %	1.0 %	0.0 %	0.0 %	0.0 %	0.2 %	0.8 %	0.0 %
Trade/TPP Issues (Pro/Con/Neutral Mentions)	0.8%	1.1 %	0.5 %	1.0 %	1.2 %	0.6 %	1.0 %	0.1 %	1.3 %	0.5 %	0.0 %	0.0 %	1.2 %	0.2 %	0.9 %
Electoral Reform Needed, Proportional Representation	0.2%	0.2 %	0.1 %	0.4 %	0.0 %	0.0 %	0.0 %	0.4 %	0.7 %	0.0 %	0.9 %	0.0 %	0.0 %	0.3 %	0.0 %
Control/Ownership of our Assets, Limit US Infringement in our Economy, Sovereignty of our Nation's Resources	0.5%	0.6 %	0.4 %	0.6 %	0.6 %	0.3 %	0.8 %	0.1 %	1.9 %	0.6 %	1.2 %	0.0 %	0.3 %	0.0 %	0.0 %
Export our Oil, Build a Pipeline for Access/Transportation	0.4%	0.4 %	0.3 %	0.0 %	0.4 %	0.8 %	0.5 %	0.3 %	0.4 %	2.5 %	1.5 %	0.0 %	0.0 %	0.0 %	0.0 %
Other	1.9%	2.2 %	1.6 %	3.2 %	1.1 %	2.0 %	0.7 %	1.4 %	2.9 %	2.8 %	3.0 %	0.0 %	2.3 %	0.2 %	2.3 %
Don't know/ No response	7.7%	6.2 %	9.1 %	10.1 %	7.8 %	7.4 %	6.6 %	5.7 %	7.4 %	3.4 %	7.5 %	13.1 %	7.2 %	9.1 %	11.9 %

The survey was conducted with 2,098 Canadians aged 18 and over from February 16-26, 2016. (Source: EKOS, 2016)

Appendix A-2: Most Important Issues in Canada (Abacus Data)

Abacus Question "What do you see as the most important issue facing Canada today?"	**Overall**	**LPC**	**CPC**	**NDP**	**Under 45**	**45+**	**BC**	**AB**	**SK/MB**	**ON**	**QC**	**ATL**	**Men**	**Women**
The economy in general	34%	38%	51%	27%	32%	37%	27%	47%	32%	35%	33%	33%	38%	31%
Health care	14%	18%	11%	12%	10%	18%	11%	7%	17%	12%	20%	17%	12%	16%
Poverty or inequality	14%	13%	7%	25%	14%	14%	7%	17%	12%	11%	3%	15%	14%	14%
Unemployment	9%	6%	10%	7%	12%	8%	7%	17%	12%	11%	3%	15%	9%	10%
The environment or climate change	8%	9%	1%	14%	10%	7%	10%	5%	6%	9%	8%	7%	7%	10%
Immigration	5%	3%	6%	2%	6%	5%	4%	6%	10%	4%	7%	4%	7%	4%
Housing	5%	4%	3%	4%	7%	3%	15%	1%	1%	7%	1%	1%	4%	6%
Education/schools	4%		3%	5%	5%	3%							4%	4%
Crime/Law and order	3%		4%	3%	2%	4%							3%	3%
Terrorism	2%		3%	2%	2%	3%							2%	2%
Foreign affairs or defence	1%				1%	1%							1%	1%

The survey was conducted with 2,200 Canadians aged 18 and over from November 11 to 13, 2016. (Source: Anderson & Coletto, 2016)

Appendix A-3: Most Important Issues in Canada (CBC Data)

CBC Question "What issue is most important to you in this election?"	Overall	18-34 Years Old	35-54 Years Old	55+ Years Old	Men	Women	BQ Party	GRN Party	CON Party	LIB Party	NDP Party
Economy	36.28%	29.39%	37.33%	38.28%	40.22%	32.38%	19.00%	17.00%	56.00%	37.00%	27.00%
Jobs	5.61%	4.54%	6.31%	5.56%	5.30%	5.91%		2.00%	4.00%	7.00%	6.00%
Taxes	5.62%	4.89%	8.02%	4.33%	5.57%	5.68%		3.00%	1.00%	5.00%	4.00%
Environment	11.26%	15.44%	11.78%	9.27%	8.43%	14.05%	14.00%	42.00%	3.00%	9.00%	15.00%
Foreign policy	2.24%	3.22%	2.18%	1.89%	2.10%	2.38%	1.00%		3.00%		2
Military	0.83%	0.97%	1.01%	0.65%	1.03%	0.63%					
Law and order	2.64%	2.52%	3.00%	2.45%	2.92%	2.36%	0.60%			1%	2%
Immigration	1.30%	1.84%	1.49%	0.96%	1.13%	1.46%					
Women	1.30%	1.84%	1.49%	0.96%	1.13%	1.46%					
Aboriginals	0.69%	1.49%	0.61%	0.44%	0.40%	0.99%					
Social programs	2.21%	4.36%	2.29%	1.31%	1.36%	3.05%					
Health	10.54%	7.16%	8.67%	13.11%	6.48%	14.56%	16.00%	7.20%	6.80%	11.00%	13.00%
Education	4.45%	8.03%	4.12%	3.26%	2.52%	6.36%	11.00%		2.00%	4.00%	6.00%
Inequality	4.79%	6.39%	4.15%	4.59%	3.94%	5.63%			2.00%	4.00%	7.00%
Seniors	2.75%	0.13%	0.93%	4.99%	2.28%	3.22%	0.70%	0.90%			3.00%
Quebec	1.33%	1.22%	1.27%	1.40%	1.62%	1.04%					

CBC Question “What issue is most important to you in this election?”	**Overall**	**18-34 Years Old**	**35-54 Years Old**	**55+ Years Old**	**Men**	**Women**	**BQ Party**	**GRN Party**	**CON Party**	**LIB Party**	**NDP Party**
Language	0.05%	0.06%	0.02%	0.06%	0.05%	0.04%					
Religious accommodation	0.25%	0.27%	0.25%	0.24%	0.29%	0.21%					
Arts and culture	0.51%	0.62%	0.52%	0.46%	0.47%	0.55%					
Democratic reform	2.33%	2.36%	1.82%	2.66%	2.71%	1.96%	1.00%		0.50%	3.00%	4.00%
Infrastructure	0.54%	0.77%	0.45%	0.50%	0.62%	0.45%					
Partisan comments	4.46%	3.48%	4.10%	5.09%	4.84%	4.09%	0.90%	5.00%	1.00%	7.00%	6.00%
Privacy	1.33%	3.36%	1.23%	0.60%	1.62%	1.05%					
Moral issues	1.33%	2.70%	1.18%	0.88%	1.18%	1.47%					
Government accountability	7.13%	4.34%	5.92%	9.02%	8.25%	6.02%		8.00%	4.00%	11.00%	7.00%

The survey was conducted with 164,704 Canadians aged 18 and over from August 29 to September 1, 2015. (Source: CBC, 2015)

Appendix A-4: Perceived Safety of Oil Transport by Pipelines

EKOS Question "How safe do you think [pipelines] are to transport oil long distances?"		Gender		Age					Region					
	Overall	**Male**	**Female**	**<35 Years Old**	**35-44 Years Old**	**45-54 Years Old**	**55-64 Years Old**	**65+ Years Old**	**BC**	**AB**	**SK**	**MB**	**ON**	**QC**	**Atl.**
Safe	69.7%	77.6%	62.6%	61.3%	65.4%	74.2%	71.6%	79.0%	68.7%	90.9%	85.1%	62.7%	74.5%	51.3%	73.7%
Not safe	28.0%	20.8%	34.5%	35.4%	31.7%	23.2%	27.3%	19.5%	30.0%	8.3%	14.9%	32.3%	24.3%	44.3%	22.1%
Don't know/ No response	2.3%	1.6%	2.9%	3.2%	2.9%	2.5%	1.1%	1.5%	1.2%	0.9%	0.0%	5.0%	1.3%	4.4%	4.2%

The survey was conducted with 2,098 Canadians aged 18 and over from February 16-26, 2016. (Source: EKOS, 2016)

Appendix A-5: Perceived Safety of Oil Transport by Trains

EKOS Question "How safe do you		Gender	Age	Region

think [trains] are to transport oil long distances?"															
	Overall	Male	Female	<35 Years Old	35-44 Years Old	45-54 Years Old	55-64 Years Old	65+ Years Old	BC	AB	SK	MB	ON	QC	Atl.
Safe	45.5%	47.6%	43.8%	47.7%	49.5%	51.7%	40.8%	36.5%	43.9%	51.0%	51.5%	52.2%	53.1%	28.8%	52.2%
Not safe	52.9%	51.3%	54.3%	49.3%	49.2%	47.1%	58.7%	62.3%	53.4%	47.8%	48.5%	44.5%	45.8%	69.8%	45.5%
Don't know/ No response	1.6%	1.1%	1.9%	3.0%	1.2%	1.2%	0.5%	1.2%	2.7%	1.2%	0.0%	3.2%	1.2%	1.4%	2.3%

The survey was conducted with 2,098 Canadians aged 18 and over from February 16-26, 2016. (Source: EKOS, 2016)

Appendix A-6: Perceived Safety of Oil Transport by Trucks

EKOS Question “How safe do you think [trucks] are to transport oil long distances?”		Gender		Age					Region						
	Overall	Male	Female	<35 Years Old	35-44 Years Old	45-54 Years Old	55-64 Years Old	65+ Years Old	BC	AB	SK	MB	ON	QC	Atl.
Safe	43.7%	42.6%	45.2%	46.4%	50.6%	50.8%	38.4%	31.2%	43.1%	44.9%	49.2%	44.7%	46.0%	35.8%	55.3%
Not safe	54.9%	56.4%	53.1%	51.3%	47.6%	48.4%	61.3%	67.4%	55.3%	53.9%	50.8%	52.1%	52.7%	62.7%	43.8%
Don't know/ No response	1.4%	1.0%	1.7%	2.3%	1.8%	0.9%	0.3%	1.4%	1.6%	1.2%	0.0%	3.2%	1.2%	1.5%	0.9%

The survey was conducted with 2,098 Canadians aged 18 and over from February 16-26, 2016. (Source: EKOS, 2016)

Appendix A-7: Perceived Safety of Oil Transport by Boats

EKOS Question “How safe do you think		Gender	Age	Region

[boats] are to transport oil long distances?”															
	Overall	Male	Female	<35 Years Old	35-44 Years Old	45-54 Years Old	55-64 Years Old	65+ Years Old	BC	AB	SK	MB	ON	QC	Atl.
Safe	49.6%	60.3%	40.3%	43.4%	48.9%	56.3%	49.6%	52.1%	44.8%	58.5%	48.7%	39.7%	53.0%	40.5%	65.8%
Not safe	49.1%	39.0%	58.1%	54.5%	50.0%	42.5%	50.2%	46.7%	53.8%	40.6%	51.3%	57.0%	45.8%	58.3%	32.5%
Don't know/ No response	1.3%	0.8%	1.6%	2.1%	1.2%	1.2%	0.3%	1.2%	1.3%	0.9%	0.0%	3.2%	1.2%	1.1%	1.7%

The survey was conducted with 2,098 Canadians aged 18 and over from February 16-26, 2016. (Source: EKOS, 2016)