The Keystone XL Pipeline Dispute: A Strategic Analysis

by
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A thesis
presented to the University of Waterloo
in fulfillment of the
thesis requirement for the degree of

Master of Applied Science
in
Systems Design Engineering

Waterloo, Ontario, Canada, 2013

AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Abstract

TransCanada Corporation has proposed the Keystone XL pipeline project to transfer crude bitumen from the oil sand fields in northern Alberta, Canada, to oil refineries located in the southern part of the United States. This project has created controversy at the national level in the US and Canada and at the international level. The existence of various stakeholders with differing wants and needs has embroiled the Keystone XL in a complicated strategic dispute. This dispute was initially ignited by the potential project's negative environmental impacts. However, economic and political issues have also played a critical role in further complicating the decision process.

The objective of this study is to design a strategic decision-making system for use in assessing the Keystone XL conflict with standard and perceptual graph model methods. Standard graph model analysis consists of various steps. After identifying the decision makers (DMs) subjectively, their options and preferences are determined. Then, possible scenarios or combinations of options for these DMs are evaluated. In the next step, based on rules called solution concepts, a standard stability analysis is conducted.

The perceptual graph model technique, on the other hand, considers the emotions and perceptions of DMs in a conflict to assess the existing dynamics among them. Although this technique takes its basic structure from the standard graph model technique, it presents unique insights into each DM's perspectives toward the conflict and other DMs. This technique has been used in this study to understand how the awareness of one DM regarding other DMs' perceptions can change reactions and strategies under different conditions regarding the Keystone XL conflict.

Acknowledgements

I would like to express my sincere gratitude to my supervisors, Professors Keith W. Hipel and Amer Obeidi for their stimulating suggestions and encouragement, support, remarks and engagement throughout the duration of my graduate studies.

Dr. Hipel's respectful, kind and carrying personality always motivated me not to give up in the face of various challenges with which I was confronted. I could confidently state that Dr. Hipel is one of the most influential five persons in my life. In a country so far away from home, his energetic and optimistic personality always reminds me of my father who I love deeply. In short, my gratitude toward him cannot be expressed in words.

Equally, Dr. Obeidi with his extensive knowledge has always encouraged me toward presenting my best work. His compassionate and insightful personality created an invaluable opportunity for me to eagerly come up with innovative and unique ideas. I feel fortunate having him as my co-supervisor and greatly appreciate his time and insightful guidance in helping me to learn and successfully accomplish my degree requirements.

I would like to extend my gratitude to my readers Professors Jatin Nathwani and Andrea Scott for kindly reading my thesis and giving precious feedback that has helped me to improve my thesis.

I would also like to thank the faculty, staff, Conflict Resolution Group members, and students in Systems Design Engineering. I also extend my special thanks to Mr. Conrad Hipel who kindly assisted me in proofreading my thesis; his valuable comments have greatly improved my work.

I would like to thank my loved ones; my precious parents Dr. Gholamhassan Payganeh and Mrs. Azar Azizi Shalbaf, and beloved husband, Mr. MirHossein TabatabaeiLotfi, who have supported me throughout the entire process by keeping me content and helping me to remain focused on my work. I will be grateful forever for their love.

Dedication

To the dearest of my life, my loving husband, MirHossein

Thank you for your love, encouragement,
patience, and endless sacrifices throughout my academic career. This thesis and the pursuit of my goals would not have been possible without you.

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Chapter One: Introduction

1.1. The Keystone XL Pipeline Project

The Keystone XL pipeline was first proposed by TransCanada Corporation in 2008 to transfer crude bitumen from the oil sand fields in northern Alberta, Canada, to the oil refineries in the southern part of the United States (US). As shown in Figure 1.1, this pipeline passes through six US states – Montana, Nebraska, Oklahoma, South Dakota, Kansas and Texas – and is almost 5576 kilometers in length (3460 kilometers in the US) (Hovey, 2008). Approximately 830,000 barrels of crude oil a day would be carried from the oil sands of Alberta through the Keystone XL pipeline to the Gulf Coast of the US (The New York Times, 2013).

Scientists have argue that the Keystone XL project can cause serious harm to the environment, such as land ruined by mining, negative effects on biology and water quality, especially in the Ogallala aquifer in the Nebraska region, and emission of greenhouse gases (GHGs), a critical cause of global warming. In addition, huge amounts of water, drawn from rivers such as the Athabasca River in Alberta, and energy are needed for the extraction of bitumen from the oil sands, which further increase the potential environmental threats of moving forward with the Keystone XL pipeline project (Cryderman, 2013).

In November, 2011, the US Department of State (DOS) pointed out that to satisfy the US national interest in the Keystone XL pipeline project, it was necessary to present an in-depth assessment of potential alternative routes that would avoid the Sand Hills region in Nebraska. Following this, in late December, 2011, Republicans in the US Congress put pressure on President Obama to make a decision regarding the Keystone XL pipeline project within 60 days.

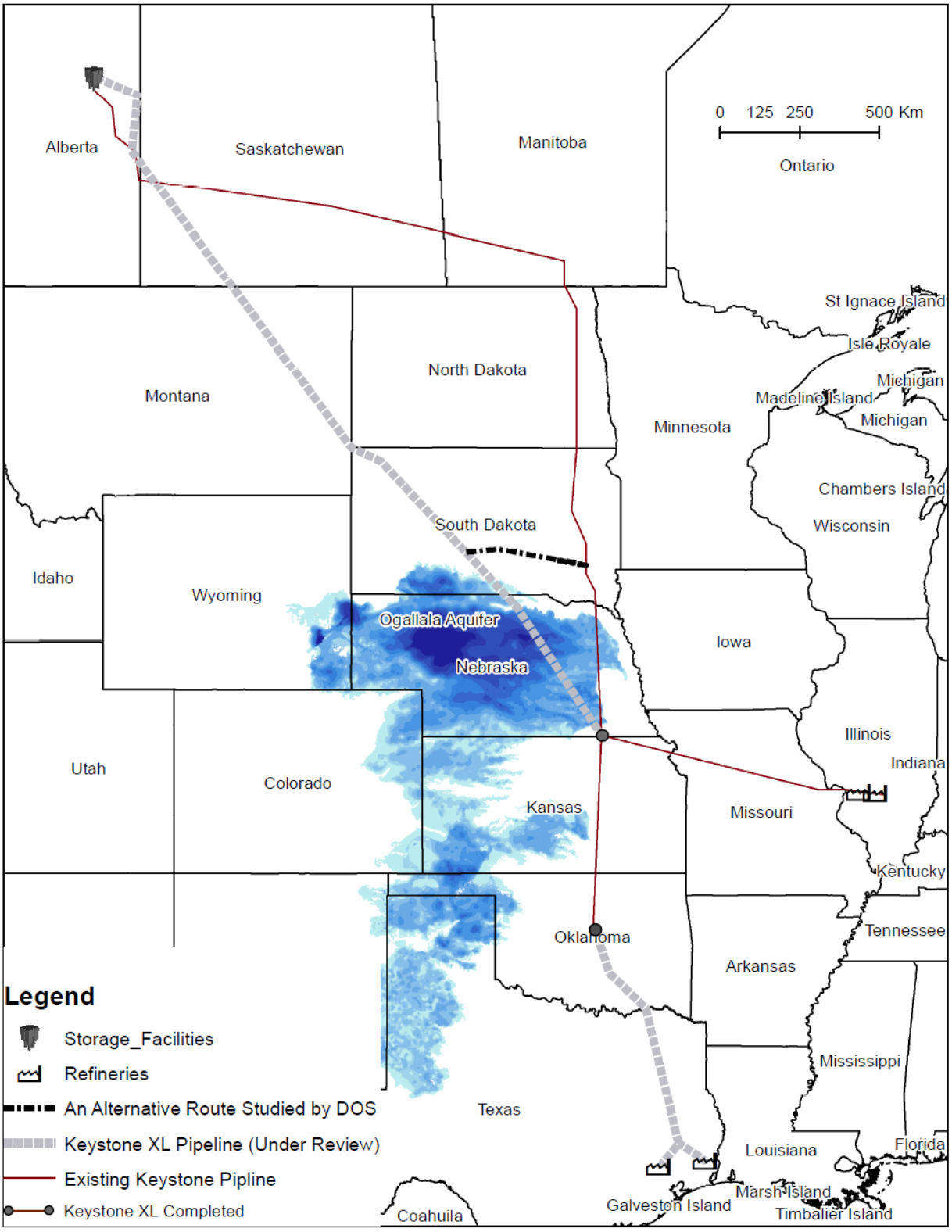

Figure 1.1: Proposed Routes by TransCanada

(The above map has been developed based on TransCanada [2012])

In January, 2012, the DOS announced that "there was insufficient time to develop and assess information regarding alternative pipeline routes in Nebraska" (TransCanada, 2012). Subsequently, TransCanada and Nebraska's Department of Environmental Quality (NDEQ) began cooperating to find an alternative route for the Keystone XL pipeline that would avoid the Sand Hills of Nebraska. In April, 2012, alternative corridor options were submitted by TransCanada to NDEQ.

It is anticipated that in the next step NDEQ would evaluate the public comments announced by DOS and review the routes. This process takes approximately six to nine months. On May 4, 2012, TransCanada submitted to the State Department the Presidential Permit Application for building the cross border pipeline (TransCanada, 2012). DOS announced that the decision making regarding the Keystone XL project would take place by the first quarter of 2013. If it is accepted, the construction was expected to start during early 2013, with an anticipated in-service date of two or three years (TransCanada, 2012). As of August 2013 a decision has not been rendered by the US President.

Complexity and controversial dimensions of the project contributed to high levels of political tension between environmentalists and supporters of the construction of the pipeline. In addition to the environmental aspects, other issues such as political and economic challenges have contributed to turning this highly charged tension into a struggle for TransCanada, the corporation proposing the construction of the pipeline. Usually, the word "conflict" in this context refers to a strong diversity of views among decision makers (DMs) that has the potential to escalate into serious negative outcomes. However, the current tension arising over the Keystone XL pipeline project is a complicated but trade dispute, which reflects a unique form of struggle and can be referred to as a "strategic conflict."

After exploring key factors underlying this strategic conflict described in Chapter 2, the Keystone XL pipeline dispute is modeled and analyzed using the graph model for conflict resolution technique (Fraser and Hipel, 1984). The main DMs, their options, and their relative preferences in the conflict are first identified. Then, a stability analysis is conducted to ascertain the potential equilibrium states or resolutions, which are stable states for all DMs.

Inconsistent perceptions, disagreements, and differing preferences among DMs are factors that could cause conflicts to occur. In the condition that negative intense emotions or asymmetric knowledge exists between the DMs, a perceptual graph model would be more useful for assessing the conflict. Furthermore, perceptual stability analysis used in the perceptual graph model technique extends beyond standard analysis techniques and gives the opportunity to study DMs' independently perceived perspectives toward the conflict. Moreover, in this technique, the awareness of each of the DMs regarding other DMs' perceptions and recognitions is also considered and evaluated systematically. Therefore, in addition to a standard graph model analysis, the perceptual graph model technique has also been used in this study to delve into the Keystone XL pipeline from different angles.

A systematic investigation of the conflict furnishes a better understanding of the dispute, how it can be more effectively managed, and other valuable strategic insights. Application of the conducted study in the real word, conclusion, and insights are provided to demonstrate the efficiency of utilizing the graph model.

1.2. Motivation for the Research

Based on current knowledge of climate science, it has become crucial to reduce the emissions of CO_2 and to replace carbon-based energy with renewable and nuclear energy. Science is

seeking alternative technology to generate, distribute, and store electricity effectively. For example, creating effective energy storage systems (batteries) with the aid of the sun, wind, nuclear energy, and other low-carbon sources is vital to defend the world from the serious negative impacts of climate change to the environment, health, ecology, and society (Canadian Academy of Engineering Energy Pathways Task Force, 2012b).

To mitigate global warming concerns, the scientific world has undertaken many related initiatives, although these efforts impose enormous pressure on countries' economies. For instance, Norway produces only 3 percent of the fossil fuels of the world. However, it has discovered a new technology to eliminate the emission of CO_2 in the air. Through this technology, CO_2 is transferred to a specific device. In the next stage, CO_2 is absorbed into a chemical element and converted to the liquid form of a chemical substance, which is stored. This process shows that fossil fuel can be used without the negative effects of emitting greenhouse gases (Black, 2012).

Before 1970, the link between global warming and greenhouse gas emissions was not recognized in oil sands mining projects (Canadian Academy of Engineering Energy Pathways Task Force, 2012b). Thus, air and water were considered free and in plentiful supply. In contrast, in today's projects, there are serious attempts to find technologies consistent with reducing water usage and repairing damage to mined lands. Extracting bitumen from oil sands using clean energy is preferable to using fossil fuel, since greenhouse gas (GHG) emissions and concerns regarding pollution of the Athabasca River would no longer be an issue (Natural Resources Defense Council, 2011). In addition, efforts are underway to reduce the amount of energy required to extract bitumen from oil sand.

Based on current evidence, the Keystone XL pipeline will increase reliance on fossil fuels, which contradicts the goal of reducing the negative effects of global warming. This study suggests that Canada not only should be aware of the various environmental impacts of its proposed pipeline projects, but also should explore possibilities regarding the use of alternative energy sources.

Although the environmental issues associated with the pipeline project are increasingly important, current technologies limit TransCanada in proposing and building a completely environment-friendly project. On the other hand, the huge financial profits of such projects for Canada motivate the country to support attempts to propose and execute them. Therefore, the Canadian Coalition, including its industry, provincial governments, and also TransCanada, has made multiple attempts to diminish the environmental effects of such projects to gain maximum economic profits and produce minimum ill effects on the environment. Moreover, the US, as a stakeholder in the Keystone XL project, has taken a complicated stance toward the project; supporters and opponents have comprehensively discussed the project's multiple dimensions in previous years, defending their points of view regarding their preferences.

This study addresses the complexities underlying the Keystone XL pipeline project. Decisions of the different stakeholders playing a role in the project are investigated, resulting in an in-depth strategic analysis of the situation surrounding this project. Through an assessment of various dimensions of this controversial project, its effects on the environments and the economies of the two neighboring countries of Canada and the US are discussed.

Figure 1.2 is the layout for the current thesis and gives a brief scheme of the study conducted here. The first two chapters explain the background and literature regarding the Keystone XL

pipeline project. Chapters 3 and 4 apply graph model for conflict resolution and perceptual graph model techniques to model and analyze the Keystone XL pipeline dispute. Chapter 5 discusses the strategic insights, in addition to the limitations, conclusions and future studies of the current thesis.

1.3. Organization of the Thesis

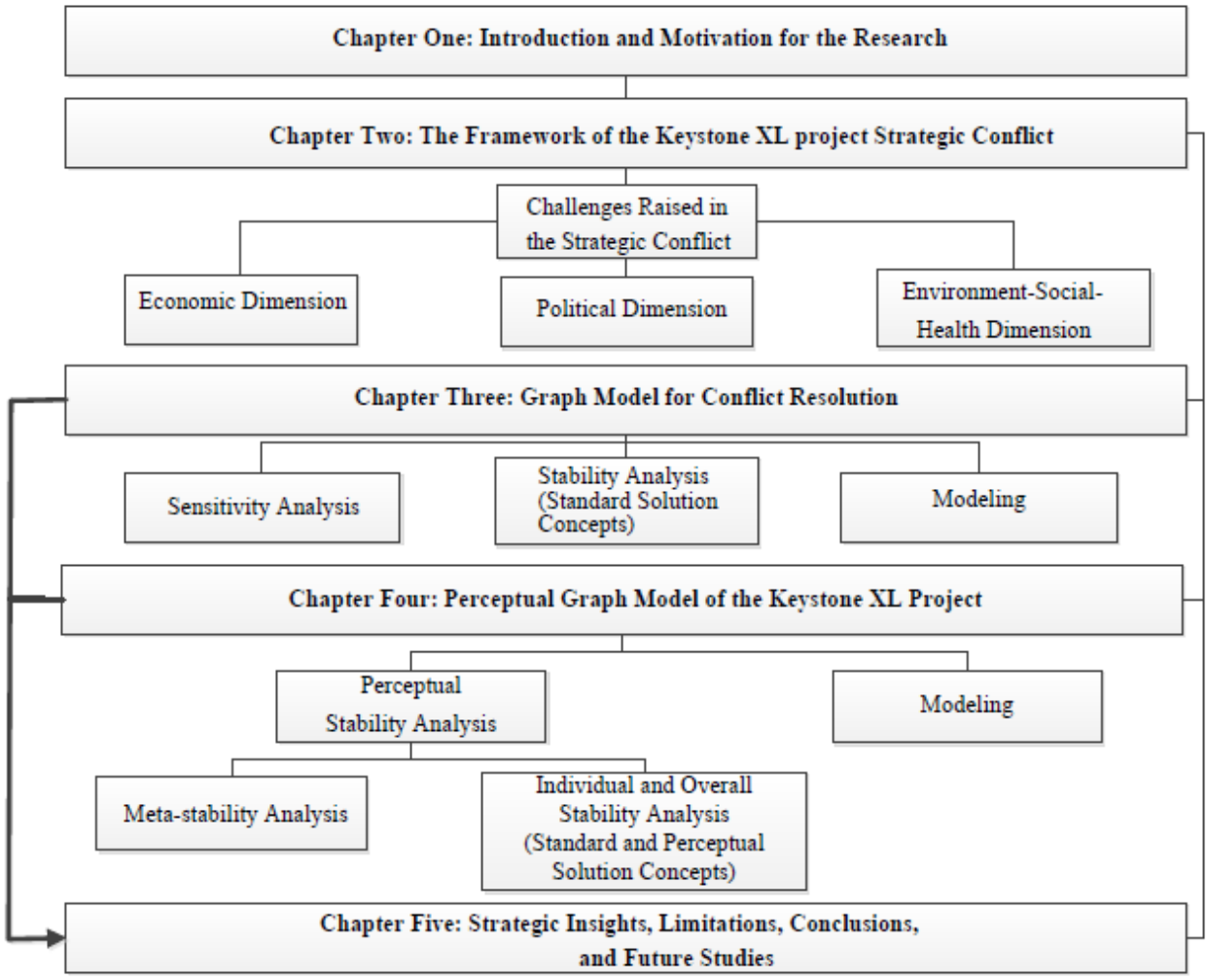

Figure 1.2: Layout of the Thesis

Chapter Two: The Framework of the Keystone XL Project

Strategic Conflict

2.1. Background

Increasing trends of human development in technological and industrial sectors have greatly raised dependency on oil resources. Although efforts to reduce our dependency on fossil fuel, and replace conventional energy sources with renewable ones, such as water, wind, and solar, as well as nuclear, have been initiated, oil and similar fossil sources of energy still play a critical role in the world. The dependency of the economy on energy hugely increases the importance of cheap production and distribution of oil worldwide. Limitations in the availability of energy sources and, more significantly, environmental concerns have led to more restrictions on producing and using oil, including oil obtained from upgrading bitumen from the oil sands. From the perspective of long term sustainability, it has become necessary for industry leaders to address environmental impacts together with economic criteria.

The Keystone XL project is causing political discord among different parties, represented by US states, the Obama Administration, influential Republicans, and the Canadian Federal government. Each party is using the project to score political or economic gains by adopting a nonconforming position. This political discord is analyzed to understand and gain strategic insights into how it may evolve. The analysis reveals a systematic approach to design decision making to configure a balance among the interests of multiple stakeholders. The following framework is proposed to study the reasons and context regarding the causes and consequences of this friendly dispute. This study examines three interrelated dimensions consisting of 1) environmental-social-health-safety, 2) politics, and 3) economic factors which underlie this

controversy. This framework will help to understand the circumstances in the strategic conflict, and contribute to constructing the model and analyzing it using the graph model technique.

2.2. Challenges Raised in the Strategic Conflict

The background investigation allows one to better appreciate key issues underlying the pipeline conflict and to construct a sensible conflict model of the situation as is done in Chapters 3 and 4. In this section, the challenges in the different dimensions of environment, politics, and economic surrounding the Keystone XL pipeline are discussed.

2.2.1. Environment-Social-Health Dimension

Despite TransCanada's endeavors to achieve the consent of opponents, current events on the ground have shown that the Keystone XL project has the potential to create serious environmental impacts (O'Rourke, 2013; Parker, 2013). For example, sections of the pipeline in the Sand Hills region of Nebraska pass through the Ogallala Aquifer, the largest aquifer in the world. This region has very porous soil, shallow groundwater, a high concentration of wetlands, broad sand dune formation, and a sensitive ecosystem. The construction of the pipeline would potentially create negative consequences for this region, place further stresses on this ecosystem, and exacerbate global warming (Parfomak, et al., 2011).

Climate change and global warming are two extremely vital topics of discussion worldwide, mainly resulting from industrial activities and GHG emissions produced by industrialized countries (Vormedal, 2010).Consequently, various environmental groups and concerned citizens, especially those who live in the Nebraska region along and in proximity to the pipeline, oppose this project (Parker, 2013).

In March 2008, DOS defended TransCanada's project, stating that "it increases US market access to crude oil supplies from a stable and reliable trading partner, Canada, which is in close proximity to the United States" (Department of State, 2008). However, the US National Environmental Policy Act (NEPA) stipulates that DOS should investigate and report the potential environmental consequences of the proposed Keystone XL project in an Environmental Impact Statement (EIS) before announcing the environmental impacts to the public (Parfomak, et al., 2011).

In April 2010, DOS instructed TransCanada to prepare the EIS report. After Cardno Entrix, a main consultant of TransCanada, completed the first EIS, the report was delivered to the DOS. However, this report received criticisms, namely that it had ignored real environmental impacts and presented an optimistic view of the effects of the Keystone XL project (Hayden, 2011).

In March 2010, the Natural Resources Defense Council (NRDC), a non-profit environmental group in New York, issued a report pointing to a huge disparity between the goal of 80 percent reduction in CO_2 emissions until 2050 and moving forward with transferring heavy crude oil from Alberta, Canada to the Gulf Coast of the US. The NRDC report stated that "the Keystone XL pipeline has the potential to increase carbon pollution by 27 million metric tons of carbon dioxide" (NRDC, 2011). Studies indicate that the average GHG results from importing and using unrefined oil sands bitumen in the US is about 6% higher than when using US refined crude oil (Government of Canada, 2008).

In July 2010, the US Environmental Protection Agency (EPA) stressed that DOS should study "greenhouse-gas emissions, air pollution, pipeline safety, wetlands and migratory-bird populations" more adequately with regard to the Keystone XL project (Welsch and Newswires, 2010). The EPA further pointed out that TransCanada will have to use and heat up underground

water and diversions from the Athabasca River in Alberta to extract bitumen from sand. This requires large amounts of natural gas and energy. In this process, thirteen chemically dangerous elements, such as arsenic and lead, will be released into rivers and aquifers. Since tar sands include sulfur and nitrogen, this can lead to the creation of other dangerous substances, such as SO_2 (Natural Resources Defense Council, 2011).

The DOS issued an announcement in August 2011, stating that "the pipeline would have no significant impact on the environment" (Jr, 2011). This statement ignited several protests in Washington, when more than 500 protesters gathered in front of the White House demanding that President Obama reject TransCanada's proposal (Gerken, 2011).

James Hansen, a leading climate change activist and former NASA scientist, also the head of NASA's Goddard Institute for Space Studies in New York City, warned that global warming is not only a prediction, it is real and happening. He was amazed by President Obama's positive opinion about continuing the Keystone pipeline project. Hansen also cautioned that, if Canada goes ahead with this project, 20 to 50 percent of the earth will be seriously in danger. He also stated in The New York Times: "if Canada proceeds [with oil sands development], and we do nothing, it will be game over for the climate." Therefore, he strongly criticized the way that the US and Canada are dealing with this issue. However, Joe Oliver, a Canadian politician and member of the Conservative Party in the House of Commons of Canada, countered that Hansen's exaggerated comments regarding the effects of the oil sands on the environment are nonsense, because the mentioned source of energy represents $1/1000^{th}$ of global emissions (CBCnews, 2013; Iranto, 2012).

Similarly, in September of 2011, nine Nobel peace prize winners, such as the Dalai Lama, signed a letter to President Obama asking that he reject the Keystone XL pipeline project. They

wrote that “the oil that would flow through the pipeline is dirty, toxic and corrosive.” However, Shawn Howard, a spokesman for TransCanada, stated that it could not be certain that the oil in other regions in the world is “conflict-free oil” (Payton, 2011). In February of 2010, Alberta’s representative in Washington D.C., Gary Mar, declared to the US House Committee on Energy and Commerce that the Alberta oil sand industry has strict regulations and standards regarding environmental preservation with respect to air, land, water, and wildlife and, more importantly, managing GHG emissions (Canadian Academy of Engineering Energy Pathways Task Force, 2012b).

In consonance with TransCanada and the Government of Alberta on March 1, 2013, DOS released another EIS draft report in response to TransCanada’s latest application of May of 2012 requesting a Presidential permit. This EIS report reflected public opinion. According to this report, the Keystone XL project will have little to no impact on the environment and GHG emissions. This announcement has appeased the oil industry and Alberta’s politicians, and further disappointed those who opposed the project (Business Roundtable, 2013). It is expected that the DOS will release an addendum report on the Keystone XL in the near future, which will influence the Obama Administration’s final decision on this project (The New York Times, 2013).

All in all, the US needs to secure its energy resource supply. It has no choice other than to buy crude oil from Canada or from other regions including the Middle East. However, the US considerably prefers to deal with Canada as its neighboring friend and ally. On the other hand, because of worldwide pressure and regulations regarding promoting environmentally sustainable industries, the US and Canada are desperate to find ways to address environmental issues in such processes as discovering, extracting and transporting energy products.

Canada asserts that it has introduced sustainable solutions to multiple environmental imperfections regarding the extraction and transportation of oil sands bitumen from Canada to the US (Canadian Academy of Engineering Energy Pathways Task Force, 2012a). For example, to extract bitumen from land, a technique called Steam Assisted Gravity Drainage (SAGD) was developed. This technique significantly reduces disturbance of land and minimizes freshwater use in extraction processes (Canadian Academy of Engineering Energy Pathways Task Force, 2012a). Moreover, the transportation of the crude oil by trucks and trains is more costly and consumes large amounts of fossil fuel, drastically increasing the amount of wasted energy and GHG emissions (Parfomak, et al., 2013; Penty and Efstathiou Jr, 2013). TransCanada argues that the Keystone pipeline project would decrease GHG emissions. This claim has led to a controversial debate among many scholars, policymakers, and environmentalists (Mccarthy, 2013).

Through collaborative work by the federal and provincial governments, Canada seriously seeks new technologies to combat any negative environmental impacts of the Keystone XL pipeline and to gain sustainable resolutions. Nevertheless, other aspects, including politics and economic concerns, intensify the complexity of the strategic conflict.

2.2.2. Political Dimension

Canada is the only country in the world with large oil reserves that is not a member of the *Organization of the Petroleum Exporting Countries* (OPEC). Canada provided fifteen percent of the US oil demand in 1998, and nineteen percent in 2008. It is estimated that this percentage will rise to 35 percent by 2035. On the other hand, the US accounts for 99 percent of Canada's oil and gas exports. Exporting oil sands bitumen from Canada shortens the supply line and, thus, is economically beneficial for the US and Canada. Moreover, the high degree of trust between the

two neighboring countries creates an encouraging atmosphere to reaching agreements on issues related to energy, shipment and refining (Canadian Academy of Engineering Energy Pathways Task Force, 2012b). According to the US federal law, project consultants should have no financial or other profits from the projects about which they consult (Hayden, 2011). One of the political issues that arose regarding the Keystone XL project was when DOS instructed TransCanada to assign contractors to investigate and write the EIS report. TransCanada procured the services of Cardno Entrix to review and inspect environmental issues involved in the Keystone XL project and to write the EIS report. In October 2011 the hiring of an outside contractor to write the EIS and the interaction of DOS and TransCanada gave rise to questions of "potential conflicts and bias." This led fourteen members of the US Congress to request the DOS's Office of Inspector to monitor the process that led to producing the EIS report (Parfomak et al., 2011). Critics were worried that TransCanada and Cardno Entrix would have financial conflicts of interest, because implementing the project will create large and long-term financial profits for Cardno Entrix, which might affect the quality of the report and credibility of information and advice it produces. In addition, because TransCanada has paid Cardno Entrix to write the report, DOS does not have control and monitoring oversight over the conducted study.

In a different context, the destiny of the Keystone XL project has become a subject of conflict at the national level between the Democratic and Republican Parties in the US. News media commentaries indicate that the Keystone XL project has turned into a "political football" in the US. One main cause of the dispute is that the Keystone XL is considered an international project, which means its approval or rejection is not directly under the authority of the US Congress. Regulations require that, for the project to be approved, a presidential permit must be issued and announced by DOS. This process requires a comprehensive inquiry into whether the various

aspects of the project satisfy US "national interests." However, Congress plays an "oversight role" through federal environmental organizations and processes (Parfomak et al., 2011).

As reported by the Cable News Network (CNN), Republicans were trying to force President Obama to approve the project even before carrying out an adequate review on the environmental impacts of the project. Although there were no doubts about the economic benefits of operating the pipeline, it is suspected that the Republicans' prime objective was to use this project to pressure the Democrats during the November 2012 presidential election (Cohen, 2012). On the other side of the political spectrum, 50 Democratic members of Congress signed a petition to be sent to the Secretary of the DOS in June 2010 to address the importance of investigating such areas as clean energy, public health preservation, GHG emissions and climate change (Congress of the United States, 2010).

One of the tipping points of the conflict emerged when President Obama rejected TransCanada's proposal on January 18, 2012. DOS stated that Republicans were trying to pass legislation to force the President to render a decision on the project within 60 days. President Obama stated: "I'm disappointed that Republicans in Congress forced this decision, but it does not change my administration's commitment to American-made energy," and "we will continue to look for new ways to partner with the oil and gas industry to increase our energy security" (Argitis and Loon, 2012). Likewise, he emphasized that: "the rushed and arbitrary deadline insisted on by Congressional Republicans prevented a full assessment of the pipeline's impact, especially the health and safety of the American people, as well as our environment" (Alberts, 2012). President Obama expressed his disappointment regarding Congressional Republicans who pressured him to make such a decision (Argitis & Loon, 2012). Although President Obama

rejected the project, he kept his support regarding the project, indirectly requesting modification from TransCanada (O'Rourke, 2013).

Based on many indicators that reflect a close relationship between Canada and the US, to avoid the Sand Hills of Nebraska on May 4, 2012 TransCanada submitted an alternative route for the pipeline. This provoked numerous negative reactions. For example, some opponents to the project stated that it should also be reviewed by an independently elected group that regulates utilities, such as the State's Public Service Commission. Also, on July17, 2012, the Nebraska Department of Environmental Quality (NDEQ) released an initial response report regarding the alternate route proposed by TransCanada for the Keystone XL pipeline. The report stated that the alternate route still goes through sandy soils, which are similar to the Sand Hills of Nebraska. The final authority to approve the proposal does not lie with the NDEQ but with the US Government (Attorney, 2012).

Senate Republicans intended to speed up the Keystone XL Pipeline process by pushing DOS through its approval and giving it to Congress, but Senate Democrats prevented this procedure (Clayton, 2012). *Globe and Mail* reported that the southern part of the Keystone XL project was confirmed and supported by the Third Army Corps district to begin construction. However, Canada will have to wait until after the US presidential election to act with regard to the northern part (Fawcett, 2012).

One speculation regarding President Obama's decision to postpone the response to TransCanada's proposal is that he intended to prevent making such a critical decision before the 2012 presidential election (The Globe and Mail, 2013). However, Republicans imposed pressures in Congress and the media to prevent President Obama from postponing the decision. Furthermore, Mitt Romney, who was President Obama's Republican contender in the election,

emphasized that the approval of the Keystone XL pipeline would be the first order of his administration (Yakabuski, 2012).

After months of investigations regarding the Keystone XL project, DOS released an EIS report on March 1, 2013, in which it agreed that the project will have little impact on the environment. Subsequently, the top Republican in Congress, House of Representatives Speaker John Boehner, said that the report "again makes clear there is no reason for this critical pipeline to be blocked one more day." He asserted further that, after four years of waiting and "needless delays," it is time "to stand up for middle-class jobs and energy security and approve the Keystone pipeline" (Daly, 2013). Ultimately, Joe Oliver, Canadian politician and member of the Conservative party in the House of Commons of Canada in a speech given *at Center for Strategic and International Studies in Washington, DC* stated that, "Ultimately this comes down to a choice. The U.S. can choose Canada — a friend, neighbor and ally — as its source of oil imports, or it can choose to continue to import oil from less friendly, less stable countries with weaker — or perhaps no — environmental standards" (CBCnews, 2013).

After DOS's March 2013 EIS announcement, *The New York Times* published an editorial against the Keystone XL pipeline on March 10. It stated that "saying no to the pipeline will not stop Canada from developing the tar sands, but it will force the construction of new pipelines through Canada itself. And that will require Canadians to play a larger role in deciding whether a massive expansion of tar sands development is prudent. At the very least, saying no to the Keystone XL will slow down plans to triple tar sands production from just under two million barrels a day now to six million barrels a day by 2030" (The New York Times, 2013).

The rejection of the Keystone XL project in January of 2012 by President Obama has further complicated the relationship between Canada and the US. The Prime Minster of Canada stated

that “this is clearly the biggest infrastructure project on the continent, and once the election is settled, we believe it will be approved” (Efstathiou, 2012). But, he emphasized that, if the US does not approve the project this time, Canada will probably diversify its energy exports to Asia, a decision that would not favor US interests at all. Even before proposing the alternative route in May of 2012, he mentioned on April 2, 2012 that Canada’s decision regarding shipping oil to Asia is a viable option. He highlighted that after the rejection of the Keystone XL project by President Obama in January of 2012, Canada realized that it should not rely on one customer, by which he meant the US. This could be the reason for the Prime Minister’s various visits to China, Japan, Thailand, South Korea and other Asian countries right after the US’s decision to reject the project (ICTMN, 2012; Potter, 2012).

According to a study conducted by the Alberta government in 2005, Asian markets are ready to pay large amounts of money for Canada’s diesel-rich bitumen components, which would represent substantial revenue for Canada (Canadian Academy of Engineering Energy Pathways Task Force, 2012b). In addition, 74.7 percent of Canadians concur with diversifying Canada’s markets by shipping energy resources to Asian markets (Nanos and Thompson, 2012). However, many environmentalists, and concerned citizens in Canada and the US are opposed to the whole idea of the Keystone XL project (Perdomo and Vieira, 2012).

In line with the decision to diversify markets, Canada is actively pursuing another project entitled the Enbridge Northern Gateway Pipelines, which would transfer oil sands bitumen to the coasts of British Columbia (BC) to be exported by oil tankers to Asian markets (ICTMN, 2012; Potter, 2012). In regards to this project, the US Department of Energy stated that because of “short marine distances to major northeast Asia markets, future expected growth there in refining capacity, and increasing ownership interests by Chinese companies especially in oil sands

production" (Ensys Energy, 2010, p. 118), the pipeline to the BC coast would surely be used. This would cause some of Canada's crude oil to be transferred to Asia instead of the US. In turn, the balance of the market would change and consequently negatively affect the US because of its increased dependency on import from other sources than Canada (Ensys Energy, 2010).

All in all, Canada's announced intentions to diversify the crude oil market to the Asian markets is considered to be a leverage Canada is using to pressure the US administration to give presidential approval regarding the project. By proposing to transfer Alberta oil sands bitumen to the US, the Keystone XL pipeline project has become a serious controversial topic in the US and Canada. Unquestionably, the political conflicts at the national level in the US and Canada's actions at the international level have seriously affected the dynamics of the diplomatic relationship between these two neighboring countries (Efstathiou, 2012).

2.2.3. Economic Dimension

Although extending the pipeline from Alberta to the West Coast of the US has caused many protests by environmentalists, fishermen and aboriginal groups, it has been shown to provide an enormous business opportunity for investors, producers and developers (Canadian Academy of Engineering Energy Pathways Task Force, 2012a). The Government of Canada estimates that if the Keystone XL project is approved, close to one hundred thousand jobs per year will be created in the US between 2010 and 2035. With increased pipeline capacity, this number could increase by 60 percent. There are huge immediate economic benefits, about 100 to 600 million dollars annually, that could potentially be gained as a consequence of transporting and processing oil sands bitumen in refineries located in Gulf Coast of the US (Hudson, 2013). Exporting oil sands bitumen from Canada shortens the supply line and, thus, is economically beneficial to the US.

A study conducted by the US Department of Energy Security in 2011 showed that Canada's oil sands could help eliminate US dependency on imports from other suppliers such as Venezuela and the Middle East. Amid a congressional hearing in December 2011, TransCanada's president stated that "Keystone XL will bring many benefits to the United States, but I believe the most important role that the Keystone will play is to bring energy security to the United States during what has been recently some very unsettling times overseas" (Clayton, 2012).

Those who oppose the project claim that oil prices in the Midwest of the US will increase if the project is executed. They believe that, "rather than providing the US with more Canadian oil, Keystone XL will simply shift oil from the Midwest to the Gulf Coast, where much of it can be exported to international buyers – decreasing US energy supply and increasing the cost of oil in the American Midwest" (Clayton, 2012).

In the case that the Keystone XL project is approved, TransCanada would lose 14 to 63 million dollars a year due to tax increases in the US, in addition to the maintenance and preservation costs of the constructed pipelines and facilities. However, overall the Keystone XL project would be financially beneficial for Canada (Moore, 2012). It is estimated that for each dollar invested in the oil sands project, there is a return of nine dollars. Out of that nine dollars, six dollars would stay in Alberta while the remainder would go to other areas of Canada, the US, and the world (Canadian Academy of Engineering Energy Pathways Task Force, 2012a).

The Keystone XL project would be economically favorable for Canadian oil sands producers and the US Gulf Coast refineries. Through the Keystone XL project, Canadian producers would expand their market to the Gulf Coast region and increase their opportunity to bargain over the

price of the crude oil because of the several high capacity refineries operating there. Subsequently, they could sell their oil at higher prices (Parfomak et al., 2011).

Canada's industry is seeking ways to increase its profits from energy projects such as the Keystone XL project. Thus, like many oil producing companies in countries such as Saudi Arabia, Iran, and Iraq, Canadian companies tend not to rely solely on exporting unrefined energy resources to the international markets. The better option is to refine energy resources in Canada and then ship them to markets to increase the value and price of those products (Canadian Academy of Engineering Energy Pathways Task Force, 2012a). This issue was raised during a seminar held in the School of Public Policy at the University of Toronto, at which Alberta's envoy to Washington, D.C., David Manning, was asked why Canada does not build refineries in Alberta to diminish the environmental impacts of the Keystone XL project, in addition to gaining more economic benefits from it. Transferring clean oil through the pipeline can to a large extent reduce concerns about global warming. However, Mr. Manning made it clear that, despite the environmental and long-term financial advantages of refining the oil in Canada, this plan is undoable because of the very high costs and investments it would demand. Consequently, Canada does not have a short-term plan to build refineries in Alberta and will be transferring the oil sands bitumen to the US Gulf Coast to be refined.

Although the Keystone XL project seems to be economically beneficial for the US, the project's financial benefit for Canada should be investigated from both short- and long-term perspectives. Canada can build pipelines to the US to ship unprocessed bitumen to under-utilized refineries to be upgraded. This will ensure quick short-term profits for oil sand companies, the Alberta Government, and Federal Government. However, if Canada tries to upgrade the bitumen in Canada, capturing "more than $60 billion per year in value-added products and commensurate to

jobs in Canada," it would enjoy the long-term benefits of the Keystone XL project (Canadian Academy of Engineering Energy Pathways Task Force, 2012b). Figure 2.1 gives a historical summary of important occurrences that have provoked the strategic conflict regarding the Keystone XL project. Following the numbers on the figure step by step, the trend of the occurrences of this conflict can be better understood.

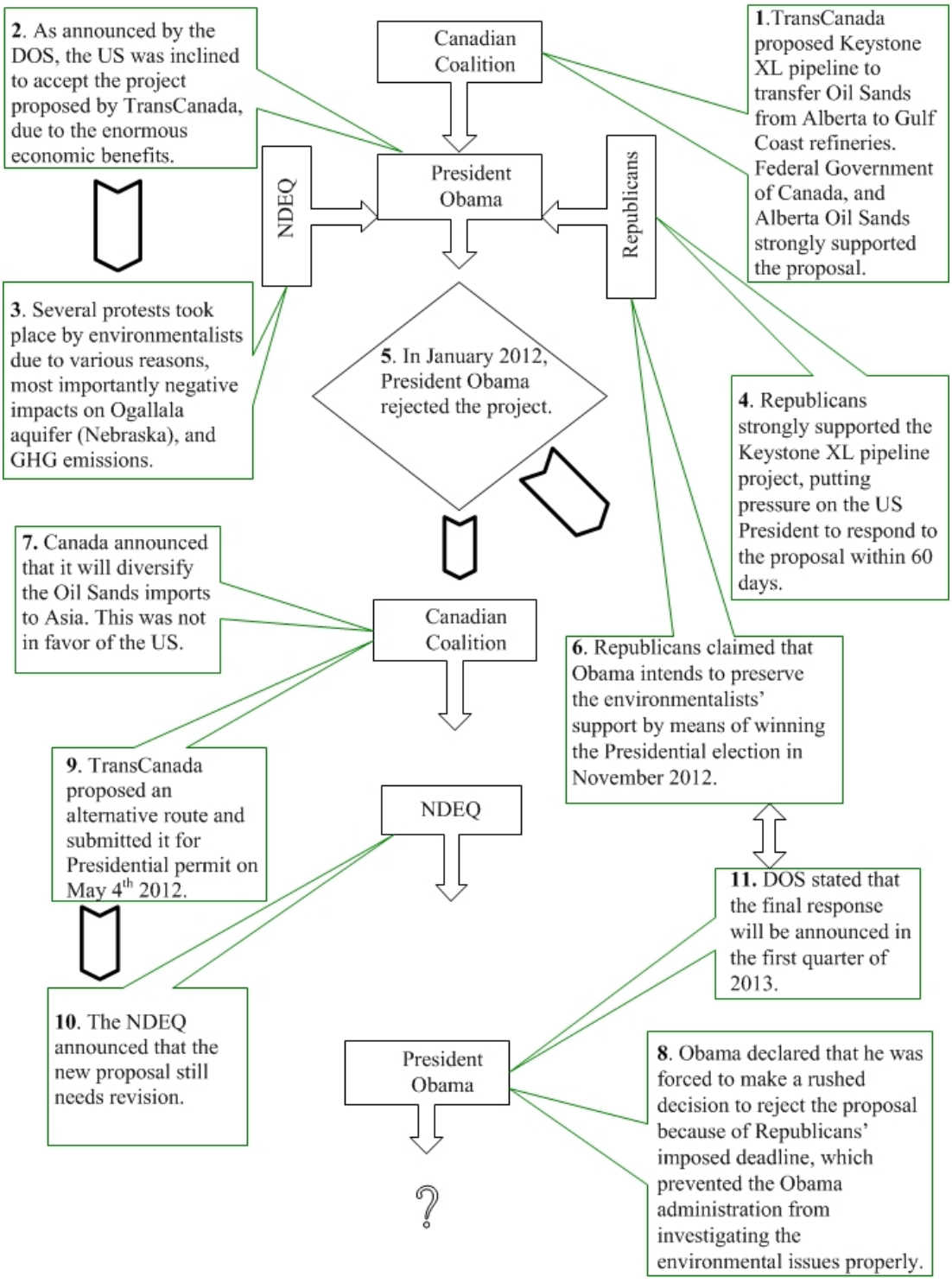

Figure 2.1: Chronology of the Keystone XL Conflict

Chapter Three: Graph Model for Conflict Resolution

Uncertainty in the economic gains and the extent of potential environmental degradation, catalyzed by the political bickering between Republicans and Democrats, contributed to creating mistrust among various stakeholders, and has led to brewing strategic conflict at the local and international levels in the US and Canada. The Keystone XL pipeline conflict is being studied using the Graph Model for Conflict Resolution (Appendix A), introduced by Fraser and Hipel (1979). This technique is unique in providing a detailed model of the dispute among decision makers (DMs). All formal definitions of this chapter explained in Appendix A.

The graph model technique consists of two parts: modeling and analysis. In the first step, the DMs are identified. In the Keystone XL case study, DMs have been categorized as critical and influential. Next, the possible options, feasible states and unilateral transitions of each DM through the states must be constituted. DMs' preferences and outcomes are ranked from the most to the least preferred for each DM. This ranking is carved out through a subjective process. In the second step of the graph model technique, stability analysis using logical rules that describe DMs' strategic interactions are applied to every outcome in the conflict model. These rules are called solution concepts and have been defined in the stability analysis section of the current thesis.

The graph model technique can potentially help to improve the decision-making procedure in conflicts. Through the use of the model, a better understanding of the options and preferences of all DMs is developed, further enhancing negotiation options and increasing the probability of win/win solutions (Hipel and Obeidi, 2005). The model used in this study was developed before the US presidential election in November 2012. Therefore, as a future study, a comparison

analysis between the model's results and the real actions of DMs could also be conducted after the announcement of the final response regarding the Keystone XL project.

3.1. The Graph Model of the Keystone XL Conflict

After the exploring key factors underlying the Keystone XL conflict, the evolution of the decision-making procedure is modeled and analyzed using the graph model technique (Hipel et al., 1997). The first step in modeling the Keystone XL conflict is to list the main and influential DMs. As summarized in Table 3.1, President Obama and Canadian Coalition are the main DMs, while Congressional Republicans and NDEQ are the influential DMs.

The main DMs are those who have the authority to decide about the project. The combinations of DMs' strategies develop the states, and the collection of all feasible combinations creates all feasible states. In this case, President Obama and the Canadian Coalition (consisting of the Federal Government of Canada, TransCanada, and Alberta Government) are the main DMs. The US and Canada are in agreement about the need and importance of constructing the pipeline. However, some significant details and circumstances, such as environmental concerns, surrounding the Ogallala aquifer and Athabasca River, and the dynamics of political rivalry during the US 2012 presidential election, are causing disagreement between these two main DMs.

Influential DMs include political parties, organizations, involved groups and states, such as the US Congress, DOS, NDEQ non-governmental organizations (NGOs), Oklahoma, Kansas, Nebraska, Montana, South Dakota and Texas, fishermen, Canada's First Nation community and lobbyists. Although parties in this category have no authority to make a final decision on the project, they have the ability to influence it indirectly through lobbing and exerting political

pressure on the main DMs. To develop a simpler and more sensible model, the Congressional Republicans and NDEQ, the most influential DMs, have been selected as representatives of the influential DMs. Republicans represent supporters of the Keystone XL pipeline project, while NDEQ represents opponents and parties who put pressure on the main DMs to resolve environmental concerns completely before granting a presidential permit.

As of September 2012, when the model was developed, there were six options for the DMs. Since an option can be chosen or not, the six options produce 2^6 states which represent all combinations of options that may occur. Therefore, each state refers to a combination of decisions that could be made by the DMs. As shown in Table 3.1, each of the main DMs has two options. President Obama could approve the project as it has been proposed or with minor modifications. The other option is to request major modifications from the Canadian Coalition. Not selecting either of these options means that President Obama intends to reject the project.

Canadian Coalition would start building the project if the President approves it or agrees to modify the project if the President requests such modification (Option 2). In the case that the Canadian Coalition accepts modification it will have to propose another route by studying different aspects of the route, especially the environmental impacts. Consequently, the Canadian Coalition should apply again for a US presidential permit. But when options three and four in Table 3.1 are not chosen by Canadian Coalition, it means that Canada will stop insisting on working with the US and think about other customers like Asia.

Option five addresses Republicans' pressures on their political opponent (Democratic Party) to approve the project. Due to the enormous economic potential of the project, Republicans strongly support the project and have been chosen in the current study as the representative of the

Keystone XL project's supporters. As an example, these supporters include the American Federation of Labor and Congress of Industrial Organizations (AFL-CIO), the nation's largest federation of unions (Greenhouse, 2013).

Option six refers to NDEQ which has an influential role as a moderate environmentalist to pressure President Obama to adequately address the environmental impacts of the project rather than immediately approving it. The priority of this DM and other environmentalists is that the construction of the pipeline not be approved.

Table 3.1: The DMs and Their Options

DMs	Options
President Obama	1- Approve the Keystone XL pipeline project (Approve) 2- Request major modifications from the Canadian Coalition (Major Modification) Note: When President Obama does not choose Options 1 and 2, it means that he is rejecting the project
Canadian Coalition	3- Build revised project as of May 2012 (Build) 4- Accept major modifications (Modify) Note: When Canada does not choose Options 3 and 4, it means that the project is canceled
Republicans	5- Pressure the President to approve the project (Pressure)
NDEQ	6- Pressure to stop the project, otherwise reduce and even eliminate all environmental impacts (Pressure to Solve or Stop)

3.2. The Set of Feasible and Infeasible States

A strategy describes a DM's decision made based on the set of options of that particular DM (Fang, Hipel, and Kilgour, 1993, p. 9). After selection of the strategy by each DM, the combinations of DMs' strategies constitute the states. Table 3.2 illustrates the option form which contains information regarding options of DMs, each DM's strategy and all the developed states, which have been indicated by a number in the bottom of the table. As shown in Table 3.2, Y means "yes", showing the situation where the option has been chosen by the DM. On the other hand, N indicates "no", which describes the situation where the option has not been selected. For example, state one is formed as (NN NN N N), in which the first two "N"s represent the strategy selected by President Obama. Notice that a DM can make transitions to other states while other DMs' strategies do not change. So, President Obama can move in the conflict model from state 5 to 6 since this transition does not require Canadian Coalition, Republicans and NDEQ to change their strategies.

After identifying the DMs and their options, states that are deemed impossible to materialize because of the logical impediments presented by the particular combination of options are called infeasible states and removed from the model. Combinations of options that are mutually exclusive create one form of logically infeasible outcomes (Fang et al., 1993, p. 34). From the 64 possible states only 24 of them are feasible or acceptable. For example, in Table 3.1, the US cannot accept the operation of the project and request major modification at the same time. In other words, from all of the options that the President has, only one option can be chosen at a time. This condition is the same for the Canadian Coalition, which has more than one option. Therefore, Canadian Coalition cannot choose Options 3 and 4 as its strategy at the same time. Stated alternatively, if President Obama decides to choose his second option (i.e., Modify) by

means of eliminating the environmental impacts, TransCanada needs to propose a new report (i.e., choose Option 4), and thus cannot start the construction (i.e., choose Option 3). Consequently, Options 2 and 3 cannot occur simultaneously.

Investigating direct specification is another method for finding infeasible states. It refers to preferentially infeasible outcomes for a DM that results from strategies chosen by other DMs. For example, if the US does not opt for both Options 1 and 2 (accept the proposal or modification), then it necessarily rejects the project. In this situation, the Canadian Coalition will not choose Options 3 or 4, thereby canceling the project.

By systematically eliminating states that are deemed to be unreasonable or unlikely to occur, many infeasible states were dropped from the model. Only twenty-four states are considered feasible as shown in Table 3.2 and explained in Table 3.3. Some of the feasible states are intermediary states. For example, according to state 5 or 11 in Table 3.3, while the project is being modified by Canadian Coalition, President Obama approves the project. The assumption in this study is that if President Obama approves the Keystone XL project, Canadian Coalition would take action and start the operation. Thus, states 5 and 11 are in-between states from when the project is approved by President Obama to when the construction of the pipeline is started by Canadian Coalition. Also state 24 is status quo and represents the current situation. Canadian Coalition modified the project due to President Obama's requisitions. Pressures from both Republicans and NDEQ continued.

Table 3.2. Standard Option Form

President Obama																								
1-Approve	N	N	Y	N	Y	N	N	N	Y	N	Y	N	N	N	Y	N	Y	N	N	N	Y	N	Y	N
2- Modify	N	Y	N	N	N	Y	N	Y	N	N	N	Y	N	Y	N	N	N	Y	N	Y	N	N	N	Y
Canadian Coalition																								
3-Build	N	N	Y	N	N	N	N	N	Y	N	N	N	N	N	Y	N	N	N	N	N	Y	N	N	N
4-Modify	N	N	N	Y	Y	Y	N	N	N	Y	Y	Y	N	N	N	Y	Y	Y	N	N	N	Y	Y	Y
Republicans																								
5-Pressure	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y
NDEQ																								
6-Pressure to Solve or Stop	N	N	N	N	N	N	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
State Numbers	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24

Table 3.3: Description of States

States	Explanation
1	The project is rejected by the US. The Canadian Coalition refuses to set up the project. No pressures from influential DMs exist. However, the results would favor the NDEQ.
2	Canada refuses to set up the project if the US requests major modification. No pressures from influential DMs exist.
3	Canada sets up the project due to acceptance by President Obama. No pressures from influential DMs exist.
4	President Obama rejects the proposal in the middle of modification by the Canadian Coalition. No pressures from influential DMs exist.
5	President Obama accepts the proposal while the project is being modified by the Canadian Coalition. No pressures from influential DMs exist.
6	The request of modification from the US is accepted by Canada. No pressures from influential DMs exist.
7	The project is rejected by the US. The Canadian Coalition refuses to set up the project. Republicans oppose this decision and continue to pressure.
8	Canada refuses to set up the project if the US requests major modification. Republicans pressure the President to accept the project.
9	Canada sets up the project due to acceptance by President Obama. Republicans pressure may have influenced this decision.
10	President Obama rejects the proposal in the middle of modification by the Canadian Coalition. Pressure comes only from Republicans, because they oppose this decision.
11	President Obama accepts the proposal while the project is being modified by the

	Canadian Coalition. Republican pressure may have influenced this decision.
12	The request by the US for modification is accepted by Canada. Pressure to accept the project comes only from Republicans.
13	The project is rejected by the US. The Canadian Coalition refuses to set up the project. One of the variables of President Obama's decision is pressure from the NDEQ on the US to abandon or completely resolve environmental concerns caused by the project.
14	Canada refuses to set up the project if the US requests major modification. One of the variables of President Obama's decision is pressure from the NDEQ on the US to abandon or completely resolve environmental concerns caused by the project.
15	Canada sets up the project due to acceptance by President Obama in spite of the NDEQ's objection.
16	President Obama rejects the proposal in the middle of modification by the Canadian Coalition. This may have been under pressure from the NDEQ.
17	President Obama accepts the proposal while the project is being modified by the Canadian Coalition in spite of NDEQ's objection.
18	The request by the US for modification is accepted by Canada. One of the variables of this decision is pressure from the NDEQ on the US to abandon or completely resolve environmental concerns caused by the project.
19	The project is rejected by the US. The Canadian Coalition refuses to set up the project. Existence of pressure from influential DMs affects the DMs' opinions.
20	Canada refuses to set up the project if the US requests major modification. Consistent pressures applied by influential DMs surround President Obama.
21	Canada sets up the project due to acceptance by President Obama. The NDEQ is not

	satisfied with the result. Republican pressure may have influenced this decision.
22	President Obama rejects the proposal in the middle of modification by the Canadian Coalition. Consistent pressures applied by influential DMs surround President Obama.
23	President Obama accepts the proposal while the project is being modified by the Canadian Coalition in spite of the NDEQ's objection. Republican pressure may have influenced this decision.
24	The US request for modification is accepted by Canada. Existence of pressure from influential DMs affects DMs' opinions. (Status quo)

3.3. Decision Makers' Preferences

As the last step of modeling, DMs' preferences in the conflict over feasible states are ordinally ranked from the most to the least preferred as illustrated in Table 3.4 (from left to right). Equally preferred states are indicated by a line drawn on top of the numbers. President Obama's priority is to proceed with the operation of the pipeline (i.e., choosing Option one). However, acceptance of the project could be conditional (i.e., requesting some minor modifications from TransCanada) to show some attention to environmentalists' concerns. If the US selects the second option, it prefers that Canada modifies the project before the US reviews the application again for a final decision. On the other hand, the US is not at all in favor of Canada ignoring the request and transferring oil sands bitumen to Asia.

The Republicans strongly insist that the project receives approval from the President for many reasons, most importantly the economic benefits of the Keystone XL pipeline (O'Rourke, 2013). Before the US elections, both sides, including the Democratic and Republican parties, used every

opportunity to pressure each other, and the Keystone XL project was one of the critical topics in their debates. Thus, whichever action President Obama might take regarding the project, Republicans would find ways to pressure him. This issue became more complex when President Obama actively sought to keep the support of environmentalists to enhance his reelection bid for another four years. In any case, President Obama is not in favor of the pressure imposed on him by the Republicans and the other proponents of the project.

In contrast, the Canadian Coalition welcomes support from the Republicans. For many reasons, the Coalition resists the NDEQ's pressure to stop or impose delays on the project. First, Canada can use the Republican pressure on President Obama to accept the project, advertising the fact that nearly half of the US population supports the project. On the other hand, Canada would prefer that the NDEQ become convinced that the project poses no serious danger to the environment. If this happens, the NDEQ would not impose any pressure to stop the project, and Canada's status would be further enhanced. Yet another issue for Canadian Coalition is the need for Canada to exhibit an environmentally friendly stance to enhance its worldwide reputation.

Both the Republican and the Democrat parties in the US oppose Canada's decision to export oil sands bitumen to Asian countries, such as China. This issue, added to the many other variables in this strategic conflict, presents an even more challenging factor for President Obama in making a decision. On the other hand, Canada uses the issue of exporting oil to China as leverage to convince the US to accept the proposal despite environmentalist pressures.

Table 3.4: Ranking the States Based on Preferences of DMs from the Most (Left) to Least (Right)

DMs	Ranking of States																							
President Obama	3	5	6	15	17	18	9	11	12	21	23	24	1	13	7	19	4	10	16	22	2	8	14	20
Canadian Coalition	3	9	21	15	5	11	23	17	6	12	24	18	8	2	20	14	17	1	19	13	10	4	22	16
Republicans	9	21	3	15	11	23	5	17	12	24	6	18	7	1	19	13	10	22	4	16	8	20	2	14
NDEQ	13,16		14	19,22		20	7,10,1,4,8,2						18	24	6,12		17	15,21,23			5,11,3,9			

As mentioned earlier, the US is the most important oil customer of Canada (Government of Canada, 2008). TransCanada has waited almost five years and proposed a new report about how to resolve the environmental impacts even after President Obama's rejection in January of 2012. Therefore, Canada's priority is for the project to not be rejected again. Canada prefers that the US accepts the project directly without requesting any other modifications. Otherwise, if the US requests major modifications that Canada is willing to accept, TransCanada will have to pay more maintenance costs for its current facilities and existing pipeline until the new project is approved and the modifications are completed. The development of Alberta's oil sands and TransCanada's pipeline are indicators of Canada's intention to become an energy superpower in the world, and the sooner the project is approved, the sooner Canada can get closer to reaching this goal.

The NDEQ represents environmentalists, who put environmental concerns as a high priority. Therefore, it is natural that their priority is different from other DMs. Many controversial discussions have occurred regarding the potential for serious environmental damages caused by the Keystone XL. Although environmental extremists do not want the project to proceed under any circumstances, the moderates, whom the NDEQ represents, believe that, if the project is to be implemented, its environmental problems must be resolved. The environmentalists also try to convince countries to change their perspectives and to enhance technologies in terms of using renewable energy rather than fossil fuel. This perspective can be of critical importance in a world in which global warming and the melting of the ice in the poles are serious issues. It is also clear that, due to national political reasons in the US, Republicans would prefer that the environmentalists' influence on the Obama administration continues.

3.4. Representing the Strategic Conflict Using the Graph Form

Figure 3.1 illustrates the integrated graph model for the Keystone XL strategic conflict. The graph model helps in illustrating a better sense of DMs' movements through the feasible states. The numbers shown at the nodes refer to the feasible states presented in Table 3.2. The arcs represent state transitions for each DM's unilateral moves from one state to another, which occur when a particular DM makes a selection from the options it controls. Although Figure 3.1 shows all movements (including improvements and disimprovements) for all DMs, in reality, when transitioning from one node to the other, the DMs consider their preferences and tend to move to more favorable states. These transitions are called unilateral improvements (UIs).

The graph model gives a better sense of players' movements toward their preferred feasible states. As illustrated in Figure 3.1, President Obama could have a transition from state 18 to state 17, which reflects the DM's preference of state 17. After the transition to state 17, Canadian Coalition could move to state 15, while Republicans would prefer to progress from state 15 to state 21. Since at state 21 none of the DMs can improve to a more preferred state, this state is stable for all the DMs. But state 21 is less preferred for President Obama than the original state, state 18. Thus, the improvement of President Obama from state 18 to 17 could eventually put him in a worse situation (state 21). According to a definition in graph model technique, states like 18 are called sequentially sanctioned for a particular DM. Therefore, although in some instances a DM can make transitions to more preferred states in the initial steps, it is better not to move from these sequentially sanctioned states since the DM ends up in a worse situation. In this case, state 18 is sequentially sanctioned for President Obama.

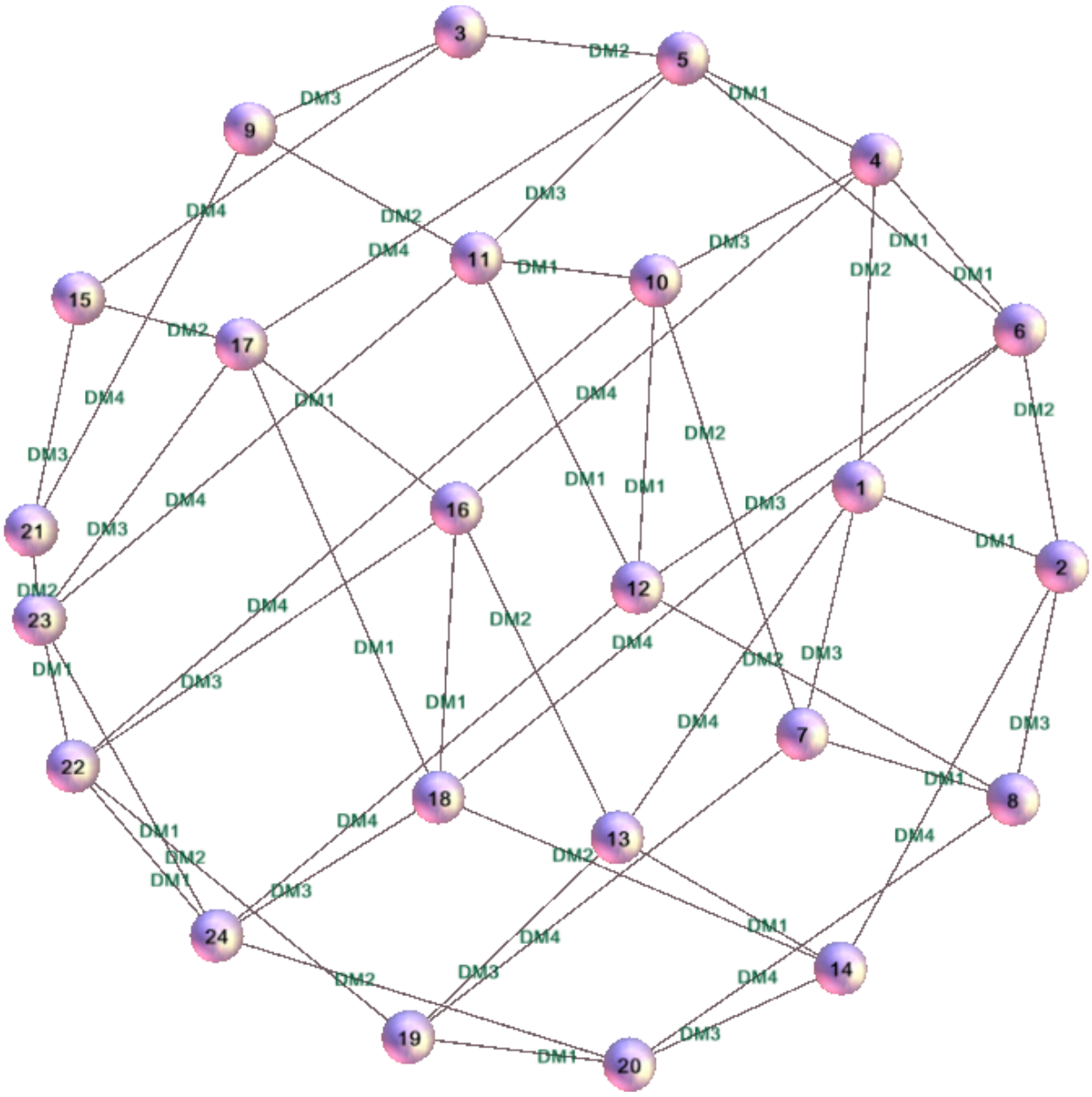

Figure 3.1: Integrated Graph Form

DM1: President Obama, DM2: Canadian Coalition, DM3: Republicans, DM4: NDEQ. Note: The relations between the arcs are all bidirectional.

3.5. Stability Analysis of the Keystone XL Strategic Conflict

After ranking the states according to DMs' preferences in order to model the Keystone XL pipeline conflict, unilateral improvements (UIs) for each DM are identified. Each DM may be able to improve to a more preferred state even if the other DMs do not change their strategies. As an example, Canadian Coalition's UI from state 5 to 3 is presented in Table 3.5. Since the other DMs do not change their strategies between these two states, Canada could improve unilaterally to a more preferred state (state 3).

Table 3.5: Example of a Unilateral Improvement (UI) for the Canadian Coalition

DMs	State 5	More preferred state for Canadian Coalition (State 3)
President Obama	1	1
	0	0
Canadian Coalition	0	1
	1	0
Republicans	0	0
NDEQ	0	0

UI

Based on a set of solution concepts explained in Table 3.6 (Fang et al., 1993), Table 3.7 reflects the studied conflict in the tableau form of the graph model. This table contains much of the information needed for analyzing the conflict. Stability analysis is conducted using the decision support system, GMCRII, to determine stable and unstable states solution concepts are a set of rules for modeling moves and countermoves of DMs in the conflict (formal definitions of

solution concepts and examples of using GMCRII software are expressed in Appendix A). They describe possible human behaviors during conflict. For instance, according to Table 3.7 and Nash stability's definition (i.e. a state is rational for a DM when the "focal DM cannot unilaterally move to a more preferred state") in Table 3.6, it is preferred and rational for Republicans to stay at state 9, since it is more preferred to state 3 which Republicans could move to unilaterally. Also, state 7 is more preferred to state 8 for President Obama. Thus, it is rational for him to stay at state 7 rather than unilaterally move to state 8. In Table 3.7, rational states for each DM have been shown by "R".

Table 3.6: Solution Concepts (Obeidi, et al., 2005)

Solution concepts	Stability description
Nash stability (R)	"A focal DM cannot unilaterally move to a more preferred state"
General metarationality (GMR)	"All of the focal DM's unilateral improvements are sanctioned by subsequent unilateral moves by others"
Symmetric metarationality (SMR)	"All of the focal DM's unilateral improvements are still sanctioned even after a possible response by this DM"
Sequential stability (SEQ)	"All of the focal DM's unilateral improvements are sanctioned by subsequent unilateral improvements by others"

Table 3.7: Stability Analysis Tableau Form for the Keystone XL Pipeline (the symbols applied in this table have been summarized in Table 3.8)

President Obama																								
Overall stability	X	X	X	X	X	X	X	X	E	E	X	X	X	X	X	E	X	X	X	X	X	X	X	X
Player stability	R	R	S	R	R	S	R	R	S	R	R	U	R	R	R	R	U	U	U	U	U	U	U	U
Preference vector	3	5	6	15	17	18	9	11	12	21	23	24	1	13	7	19	4	10	16	22	2	8	14	20
UIs			5			17			11			23					5	11	17	23	1	7	13	19
																	6	12	18	24				
Canadian Coalition																								
Player stability	R	R	R	R	U	U	U	U	R	R	R	R	U	U	U	U	R	R	R	R	U	U	U	U
Preference vector	3	9	21	15	5	11	23	17	6	12	24	18	8	2	20	14	7	1	19	13	10	4	22	16
UIs					3	9	21	15					12	6	24	18					7	1	19	13
Republicans																								
Player stability	R	R	U	U	R	R	U	U	R	R	U	U	R	S	R	U	R	R	U	U	R	R	U	U
Preference vector	9	21	3	15	11	23	5	17	12	24	6	18	7	1	19	13	10	22	4	16	8	20	2	14
UIs			9	21			11	23			12	24		7		19			10	22			8	20
NDEQ																								
Player stability	R	R	R	R	R	R	U	S	U	S	S	S	R	R	S	S	R	R	R	R	U	U	U	U
Preference vector	13	16	14	19	22	20	7	10	1	4	8	2	18	24	6	12	17	15	23	21	5	11	3	9
UIs							19	22	13	16	20	14			18	24					17	23	15	21

In some cases, although the DM's true intention is to improve to a better state, the consequence of its unilateral improvement may not be in its favor since it may give the opportunity to the other DMs to unilaterally improve despite its disagreement. As an example, if the Republicans improve from state 1 to 7, NDEQ would prefer to unilaterally improve to state 19. In this situation, it is rational for both President Obama and the Canadian Coalition to stay at state 19. As is shown in Table 3.6, state 19 is less preferred for Republicans than states 1 and 7. Therefore, state 1 is considered not Nash stable but stable for the Republicans under the definition sequential stability. In Table 3.7 sequentially sanctioned states for each of the DMs have been shown by "S". States indicated by "U" represent unstable states for a particular DM. In these states, the DM has the opportunity to improve to another state. For example, the Canadian Coalition can improve from state 23 to state 21, since the former is less preferred for all DMs, thus making state 23 unstable.

After identifying the stability of individual states for each DM, equilibrium states (overall stability) are identified. The states that are stable for all the DMs are defined as equilibrium states, shown by "E" in Table 3.7. The remaining states that have been indicated by "X" represent states that are instable for at least one DM. The symbols applied in Table 3.7 have been summarized in Table 3.8.

Table 3.8: Symbols Applied in Table 3.7

Symbols	Description
UI	Unilateral Improvement
R	Nash Stability (R) or Rational State
S	Sequentially Sanctioned State
U	Unstable State
E	Equilibrium State
X	Not Equilibrium

Table 3.9 lists the stability analysis of the Keystone XL strategic conflict, which shows that states 19 and 21 are stable for all DMs under all solution concepts (Appendix A). Other states are stable under some but not all solution concepts. In Table 3.9, state 21 (one of the equilibrium states) describes the situation in which, despite NDEQ's insistence for the elimination of environmental impacts, President Obama approves the construction of the Keystone XL pipeline.

States 19 and 21 represent consistent strategies by influential DMs and vacillating strategies by the main DMs. In state 21, US's decision appeases Canada Coalition and Republicans, while in state 19, US's decision appeases NDEQ.

Table 3.9: Stability Analysis

Solution Concepts \ States	12	19	21
Nash Equilibrium		√	√
GMR	√	√	√
SMR	√	√	√
SEQ	√	√	√

States 19 and 21 represent enforcement from influential DMs. Republicans try to push President Obama to move toward accepting the project, while the NDEQ insists that the environmental concerns should be solved before granting an approval for the project. State 19 indicates that President Obama rejects the project under pressure from the NDEQ, and Canada stops insisting on the agreement. Therefore, Asia becomes Canada's main customer (O'Rourke, 2013). In state 21, however, the US directly accepts the proposal and becomes Canada's main customer. However, there is the possibility of requesting some minor modifications while accepting the project, which could lead to appeasing the NDEQ and other moderate environmentalists.

State 12 is considered an acceptable result and relatively strong equilibrium because it satisfies the rules of all solution concepts except Nash stability (sequential choice). According to state 12, if President Obama requests modification from TransCanada, the mission of the NDEQ is done, and, pressure from the NDEQ would be eliminated. Therefore, the transition from status quo, state 24, to state 12 would occur. However, Republicans still push the opposition party (Democratic Party) to accept the project as soon as possible. In this situation, Canada will agree to apply the new modifications and will seek alternative routes.

According to Figure 3.1, if the US is in state 12, the US can unilaterally improve its position by moving to state 11, in response to which the Canadian Coalition would improve to state 9, which the Republicans do not tend to move away from to another state. However, the NDEQ prefers to improve from 9 to 21, which is less preferred by President Obama than 12. Therefore, President Obama is not in favor of moving from state 12, since he might eventually end up in state 21. Hence, state 12 is sequentially sanctioned for President Obama by other DMs.

3.6. Status Quo Analysis

The status quo, state 24 in Table 3.10, represents the current real-world situation. Other feasible states show likelihoods of DMs' movements from the status quo. Table 3.10 shows transition of DMs from status quo to state 21 which is one of the equilibrium states. Note that Y means yes and indicates the situation in which the DM has chosen the Option. As described in Table 3.10 , if the President improves from status quo, state 24, to state 23, the Canadian Coalition progresses to state 21, which is an equilibrium state for all DMs. In the Keystone XL case, state 23 is considered as an intermediary state.

Table 3.10: State Transition to State 21, an Equilibrium State

DM	Option	Status Quo	intermediary State	Possible Equilibrium State
President Obama	1	N	Y	Y
	2	Y	N	N
Canada	3	N	N	Y
	4	Y	Y	N
Republicans	5	Y	Y	Y
NDEQ	6	Y	Y	Y
State Number	-	24	23	21

Table 3.11 shows each DM's point of view regarding the project when they are in state 21. Firstly, Republicans are in competition with the Democratic Party and even if the project is approved, they would have objections because of delays in the process of approving the project. Also in NDEQ's point of view, they prefer that the project is stopped or that the environmental impacts are reduced significantly. Therefore in this equilibrium state, they would not be satisfied with the results.

Table 3.11: Description of DMs' Points of View in State 21

DMs	Description of DMs' Points of View
President Obama	Approves the proposal, while requesting minor modifications to show his consideration for environmentalists.
Canadian Coalition	Starts building the Keystone XL pipeline proposed by TransCanada in April, 2012, while using other customers (e.g., China) as leverage for economic bargaining with the US.
Republicans	Tries to find ways to show that the decision of Democrats is solely a political game (wasted time by initially rejecting the project to help Obama win the 2012 election), and thus, continue pressuring the President.
NDEQ	Not satisfied with the result; therefore, keep pressuring.

Table 3.12 shows the transition of DMs from the status quo to state 19. If the President makes a transition from status quo, state 24, to state 22, the Canadian Coalition could progress to state 19, which is an equilibrium state for all DMs. In the Keystone XL case, state 22 is considered an intermediary state. Table 3.13 briefly describes DMs' points of view in state 19. If President Obama rejects the proposal proposed by TransCanada in May 2012, Canadian Coalition would

prefer to cancel the project. In this situation, unlike NDEQ, the Republicans would not be satisfied with the results and continue their pressuring.

Table 3.12: State Transition to State 19, an Equilibrium State

DM	Option	Status Quo	intermediary State	Possible Equilibrium State
President Obama	1	N	N	N
	2	Y	N	N
Canada	3	N	N	N
	4	Y	Y	N
Republicans	5	Y	Y	Y
NDEQ	6	Y	Y	Y
State Number	-	24	22	19

Table 3.13: Description of DMs' Points of View in State 19

DMs	Description of DMs' Points of View
President Obama	Rejects the proposal due to pressure from NDEQ.
Canadian Coalition	Cancels the Project and refuses to insist. There is even a likelihood that it decides to diversify its crude oil to Asia.
Republicans	As supporters of the project, they are not satisfied with the results and therefore their pressuring would continue.
NDEQ	Are satisfied with the results, since their pressuring had an influential role on President Obama to reject the project.

Due to many factors, such as economic benefits, meeting national interests (Gasser, 2012; O'Rourke, 2013), and allowing less dependency on the Middle East for importing oil, the likelihood of President Obama approving the project is high and the occurrence of state 21 is higher compared to state 19. Moreover, if President Obama requests modification, Canadian Coalition may refuse to modify the project for applying again. This further complicates the situation for President Obama since it is not preferable for him to be denied by Canadian Coalition. Hence, the likelihood of President Obama requesting modification is low. Therefore as the results of the current study show, President Obama either approves or rejects the proposal.

3.7. Sensitivity Analysis

To examine the robustness of the proposed graph model shown in Table 3.14, the order of each DM's preference in Table 3.4 is changed subjectively, and a new stability analysis was executed. Table 3.15 shows individual stability and equilibrium results for the states in the conflict based on the new ordinal ranking of DMs' preferences. A line above some states, such as states 9 and 11 for President Obama, indicates the DM is indifferent between these states. In the original scenario, state 9 was the more preferred state for President Obama. The equilibrium states resulting from sensitivity analysis are summarized in Table 3.15.

As shown in Table 3.15, states 7, 9, 13, 18, and 19 are strong equilibria, and state 12 is again a relatively acceptable one. In comparison to the equilibria gained in the main scenario (Table 3.9) and the second scenario (Table 3.15), states 19 and 12 result as stable states for all DMs and appear in both scenarios. Therefore, the initial model proposed seems to be fairly robust and reliable. In addition, states 7, 9, 13 and 18 are new equilibria that are gained by changing DMs' preferences. These new resolutions can be interpreted within the context of the preference changes.

Table 3.14: Stability Analysis Tableau Form (Second Scenario)

President Obama																								
Overall stability	X	X	X	X	X	X	X	X	E	E	X	X	X	X	X	E	X	X	X	X	X	X	X	X
Player stability	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Preference vector	3	5	6	18	12	24	17	15	11	9	21	23	19	13	16	7	10	22	4	1	2	8	20	14
UIs			5				18		12						18		12	24	5		1	7	19	13
															17		11	23	6					
Canadian Coalition																								
Player stability	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Preference vector	3	9	21	15	17	23	11	5	6	12	24	18	2	8	20	1	7	14	19	13	10	4	22	16
UIs					15	21	9	3					6	12	24			18			7	1	19	13
Republicans																								
Player stability	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Preference vector	11	9	23	21	17	15	3	5	6	12	18	24	1	13	16	4	7	19	10	22	2	8	20	14
UIs					23	21	9	11		6		18												
NDEQ																								
Player stability	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Preference vector	13	16	14	18	6	24	12	19	22	20	7	10	1	4	8	2	3	5	11	9	17	15	23	21
UIs					18								13	16		14					5	3	11	9

Table 3.15: Equilibrium Results for the Second Scenario

Solution Concepts \ States	7	9	12	13	18	19	21
Nash Equilibrium	√	√		√	√	√	√
GMR	√	√	√	√	√	√	√
SMR	√	√	√	√	√	√	√
SEQ	√	√	√	√	√	√	√

State 18 reflects that pressures from the NDEQ cause President Obama to request modification, either directly or indirectly, and the Canadian Coalition would accept the modification. However, the Republicans prefer to remain silent. The point is that, in this real conflict, since the President is a member of the Democrat Party, Republicans will always try to find ways to put pressure on him either by using the Keystone XL project or other issues. Thus, the assumption of the existence of pressure from the Republicans is a good approximation of reality. The possibility that Republicans will not continue to pressure the President to accept the project could exist if we consider lobbying power among politicians.

States 7 and 13 both represent rejection of the project by the President. In this situation, Canada abandons the US and deals with Asia instead. This issue may be influenced by the pressure applied by the NDEQ if we assume that state 13 happens. In state 7, though, because of the sense of competition with the Democratic Party and dissatisfaction with the results, the Republicans continue to pressure President Obama if he rejects the project. Also, state 9 represents that, although the President accepts the project, Republicans, as a competitor, try to find ways to apply pressure on him in another context, such as stating that the delay in making the decision to approve the project wasted valuable time.

Table 3.16 shows a tableau form for a third scenario of the Keystone XL pipeline conflict. The order of preferences or options has not changed. The only difference in Table 3.16 compared to Table 3.7 is that DMs' irreversible moves have been considered in this table. Irreversible moves refer to situations where a particular DM cannot move back to the original state.

In the standard or main scenario, to improve the flexibility of the decision-making system, irreversible moves were not considered. However, to examine the robustness of the proposed model, two situations were considered as irreversible for the main DMs. First, the researcher assumed that if President Obama rejects the project, he cannot change his mind under any conditions (e.g., even if TransCanada insists on working with its important customer, the US, by proposing an alternative route). Second, in the case that Canada denies modification, the project would be canceled completely and, thus, Asia would become the main customer for Canada's oil sands.

According to Table 3.16 and our assumptions in the third scenario, improvement of President Obama from state 4 to states 5 and 6 is impossible. His UIs from states 10 to 11 and 12, 16 to 17

and 18, and 22 to 23 and 24 are also assumed to be impossible. Moreover, states 2, 8, 14, and 20 are irreversible for the Canadian Coalition. For example, in state 2, President Obama requests modification, but the Canadian Coalition does not agree to the modification. In this situation, and if irreversible moves are considered, the Canadian Coalition cannot make an improvement from state 2 to state 6.

Moreover, based on individual stability analysis for the third scenario, after considering irreversible moves, some states that were unstable(i.e., states 4, 10, 16, and 22 for President Obama and states 2, 8, 14, and 20 for the Canadian Coalition) turn into Nash equilibria states. These states were all unstable in the original scenario. Moreover, some states, such as states 4 and 10, were sanctioned by the main DMs for NDEQ in Table 3.7. However, in the third scenario after irreversible moves have been considered, the main DMs are banned from improving from some states. This is why states such as 4 and 10 become unstable for NDEQ and NDEQ has no worries about being sanctioned by the main DMs.

After identifying the irreversible moves, individual and overall stability analyses are conducted using standard solution concepts. States 19 and 21 are overall the most reliable equilibria states and state 12 is a relatively robust state. In sum, the analyses revealed that in the proposed model regarding the Keystone XL project, regardless of whether the analyst considers some moves as irreversible or not, the final equilibrium results are the same. Consequently, for the Keystone XL pipeline case study, the existence of restrictions for some states created by irreversible moves had no effect on the overall equilibrium results.

Table 3.16: Stability Analysis Tableau Form for the Keystone XL Pipeline (Third Scenario)

President Obama																								
Overall stability	X	X	X	X	X	X	X	X	E	E	X	X	X	X	X	E	X	X	X	X	X	X	X	X
Player stability	R	R	S	R	R	S	R	R	S	R	R	U	R	R	R	R	R	R	R	R	U	U	U	U
Preference vector	3	5	6	15	17	18	9	11	12	21	23	24	1	13	7	19	4	10	16	22	2	8	14	20
UIs			5			17			11			23					⊗5	⊗11	⊗17	⊗23	1	7	13	19
																	⊗6	⊗12	⊗18	⊗24				
Canadian Coalition																								
Player stability	R	R	R	R	U	U	U	U	R	R	R	R	R	R	R	R	R	R	R	R	U	U	U	U
Preference vector	3	9	21	15	5	11	23	17	6	12	24	18	8	2	20	14	7	1	19	13	10	4	22	16
UIs					3	9	21	15					⊗12	⊗6	⊗24	⊗18					7	1	19	13
Republicans																								
Player stability	R	R	U	U	R	R	U	U	R	R	U	U	R	S	R	U	R	R	U	U	R	R	U	U
Preference vector	9	21	3	15	11	23	5	17	12	24	6	18	7	1	19	13	10	22	4	16	8	20	2	14
UIs			9	21			11	23			12	24		7		19			10	22			8	20
NDEQ																								
Player stability	R	R	R	R	R	R	U	U	U	U	U	U	R	R	S	S	R	R	R	R	U	U	U	U
Preference vector	13	16	14	19	22	20	7	10	1	4	8	2	18	24	6	12	17	15	23	21	5	11	3	9
UIs							19	22	13	16	20	14			18	24					17	23	15	21

3.8. Summary of Graph Model for Conflict Resolution Implementation

In addition to discussing the solution concepts' definitions, Figure 3.2 introduces a brief description of the graph model procedures and how the Keystone pipeline conflict case study fits in this process. In the first step, the information required for understanding the real-world conflict has been gathered and categorized under three dimensions: environment-safety-health, politics, and economics. In the next step, the graph model technique is used to model and analyze the conflict. This step is further followed by discussing the insights of the Keystone XL conflict (in Chapter 5), which could assist DMs in their day-to-day practical experiences. The graph model for conflict resolution technique is also useful for researchers in fields such as policy making, social science, engineering, and environmental management.

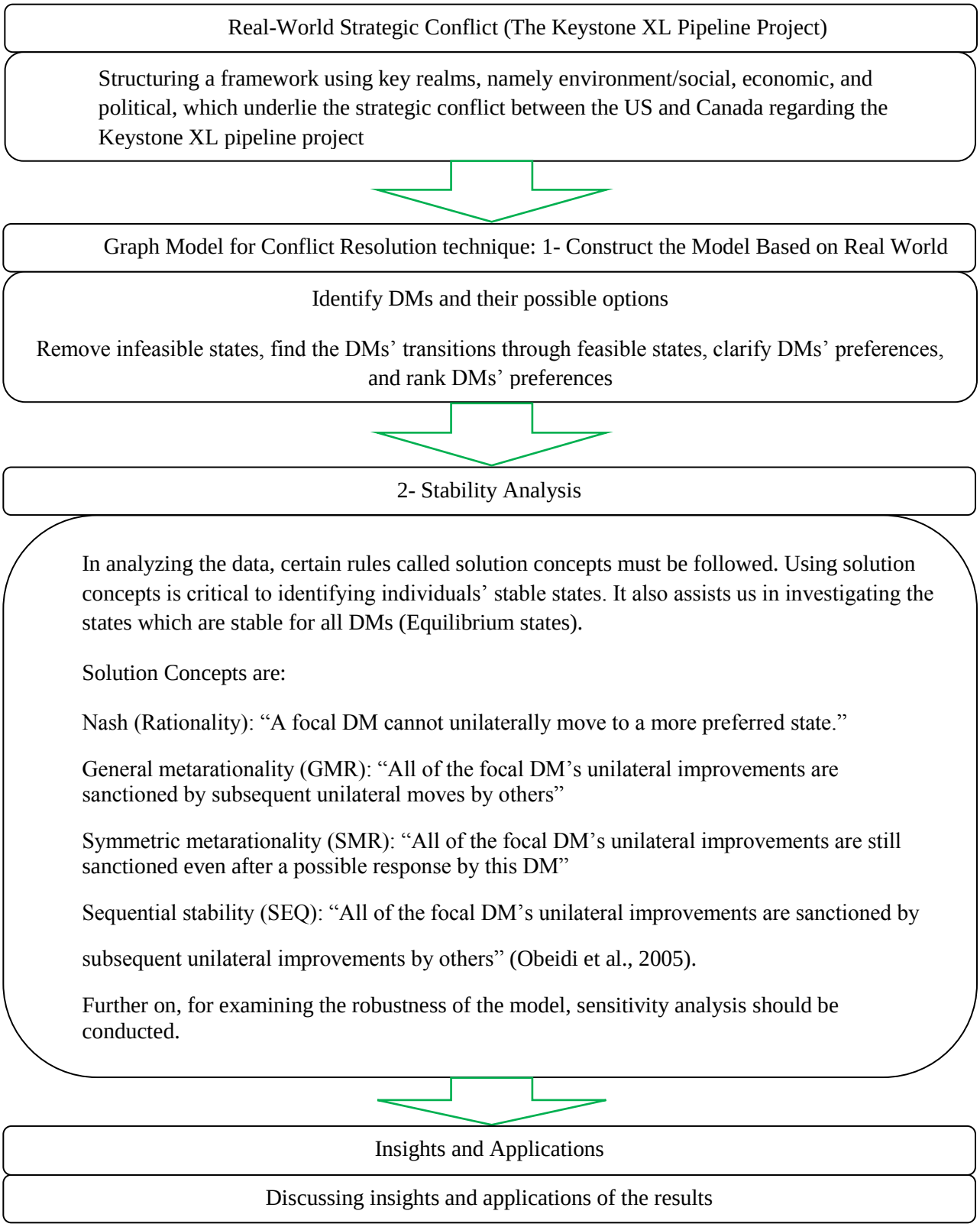

Figure 3.2: Outline of the Graph Model for Conflict Resolution

(Fang et al., 1993, p. 18)

Chapter Four: Perceptual Graph Model of the Keystone XL Project

Standard graph model analysis is a useful technique to understand complex conflicts and their DMs' options and strategies. Through this technique, equilibria states are systematically recognized, shedding light onto possible conflict solutions. However, this technique does not explicitly consider DMs' interactions and their perceptions towards each other. Perceptual graph model technique has been introduced to the literature to fill this gap. This technique incorporates DMs' emotions into the decision analysis (Obeidi, et al., 2005) and thus, assists researchers in recognizing and modeling DMs' unique perspectives towards the conflict. The definitions of the concepts related to the perceptual graph model technique have been introduced in Appendix B.

Emotions have the power to change feasible states into infeasible states, consequently eliminating them from the analysis. Some negative emotions may mask the DMs' options and their number of recognized states (Obeidi et al., 2005). For example, in the Israel-Palestine conflict, the existing anger and prejudice among the involved DMs eliminates the possibility of peaceful negotiations and communication, promoting war and aggressive attitudes.

Perceptual graph models allow modeling the way individuals conceptualize conflict independently with their own perception and awareness regarding other DMs and their perception of the conflict. Perceptual graph model develops unique stability analyses for each of these DMs, and also combines all these inconsistent perspectives into one single analysis. The individual and overall stability analyses conducted with the perceptual graph model technique provides broad and in-depth insight into the conflict. From this exhaustive perspective private and overall stable states are determined and consolidated. Overall, the states identified as stable

under more solution concepts and perspectives are more robust since they represent a broader range of stability in different situations and from different viewpoints.

In the case of the Keystone XL pipeline project, economic and power competition between the US and Asia, could push President Obama toward approving the project and ignoring environmental concerns. Emotional factors (e.g., fear that Canada could open its oil markets to rivals) could affect Obama administration's decision-making process.

At the G8 summit held in Russia in 2006, the prime minister of Canada declared that Canada is "an emerging energy superpower." This issue has led Canada to expand its energy-producing power by facilitating a variety of projects. Because of the employment opportunities and anticipated financial profits associated with the Keystone XL project, the Canadian Coalition has eagerly tried to convince the US to approve the project. The prime minister of Canada can enhance Canada's financial position through the Keystone XL project. The aim is to understand how Canadian Coalition's perspective can affect its decisions regarding the project after the US presidential response. The Canadian Coalition could either insist on constructing the project by proposing an alternative route or refuse to modify the most recently submitted proposal. In another scenario, the Canadian Coalition could cancel the project completely and deal only in the Asian market or it could accept modification but send a considerable portion of its crude oil to Asia.

Congressional Republicans have emphasized the positive aspects of the project to pressure the President to accept it. The presidential election and political dynamics in the US highlighted the role of Republicans regarding the project's destiny. The Keystone XL pipeline turned into an opportunity for them to oppose the Democratic Party. They criticized President Obama for

rejecting the project and, thus, delaying construction of the pipeline. Republicans claimed that this decision was political, meant to buy time for the Democratic Party before the November 2012 presidential election.

On the other hand, NDEQ's decisions and positions have also been directed by a deep sense of feeling and caring for the environment. All in all, the role of emotions will be further studied to assess the Keystone XL strategic conflict model to understand how emotion and inconsistent perceptions affect the visibility of states in DMs' perspectives.

The perceptual graph model technique's assumption is that negative emotions are present among the DMs to the extent that they do not perceive some feasible states. In other words, because of their emotions toward other DMs or some aspects of the conflict, some states are hidden in their perspectives. However, as mentioned earlier, the Keystone XL pipeline conflict is a friendly dispute and not a serious conflict. Although the DMs in this conflict have negative emotions and disagreements with each other, they are trying to find resolutions. Therefore, since intense emotions do not exist among DMs to explore application of the perceptual graph model in the current conflict, it is assumed that some of the least preferred states for some DMs are hidden states

In sum, after recognized and hidden states have been identified for each of the DMs, perceptual stability analysis is conducted to determine equilibria states. According to Figure 4.1, perceptual stability analysis consists of two parts. First, individual stability analysis is implemented for each of the DMs when they are aware of other DMs' hidden states and also for when they are not. After identification of individual and overall stable states for each DM in different awareness statuses, meta-stability analysis in section 4.7 is conducted. In this second

phase, the results of the first phase are consolidated and equilibrium states are identified using specific equilibrium forms and rules. The method applied in this chapter has been drawn solely from two journal papers authored by Amer Obeidi, Keith Hipel, and Mark Kilgour (Obeidi et al., 2005; Obeidi, et al., 2009).

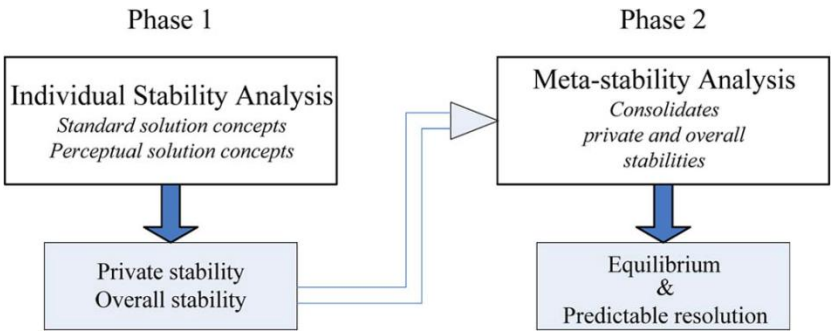

Figure 4.1: Perceptual Stability Analysis

4.1. Model Construction

Before perceptual analysis, it is necessary to construct a model. Modeling the conflict in a perceptual graph model analysis is similar to structuring a model in a standard graph model technique, explained in Chapter 3. With the aim of testing the robustness of the previously analyzed standard graph model in Chapter 3 and also showcasing the dynamic and flexible nature of the graph model technique, the Canadian Coalition's options have been slightly altered in this recent model. In the newly constructed model summarized in Table 4.1, the Canadian Coalition has two options: first, it can deny modification (deny) and second, it can diversify the bitumen gained from oil sands to Asian markets (diversify). In the model used in this section, President Obama and the Canadian Coalition are still the main or critical DMs, while Republicans and NDEQ are the influential DMs. Overall, DMs' options have not changed except for the Canadian Coalition. In section 4.2, the new model proposed in section 4.1 is analyzed

using standard graph analysis. Then in section 4.4, the new model is studied using perceptual graph models of each DM.

Table 4.1: The DMs and Their Options

DMs	Options
President Obama	1- Approve the Keystone XL pipeline project (Approve) 2- Request major modifications from the Canadian Coalition (Major Modification) Note: If President Obama does not choose Options 1 and 2, he is rejecting the project
Canadian Coalition	3- Deny modification requested by President Obama (Deny) 4- Diversify the bitumen extracted from oil sands to Asian markets (Diversify) Note: If the Canadian Coalition does not choose Options 3 and 4, either the US has approved the project or Canada intends to convince the US regarding proceeding with construction of the project
Republicans	5- Pressure the president to approve the project (Pressure)
NDEQ	6- Pressure to stop the project; otherwise, reduce and even eliminate all environmental impacts (Pressure to Solve or Stop)

4.1.2. The Set of Feasible and Infeasible States

The identification of states plays a significant role in predicting possible scenarios for the future; in the current model, the six options representing the DMs' possible actions produce 2^6 states. A brief explanation of these options is provided in Table 4.1. In the next step, infeasible states should be removed from the model.

Table 4.2 is the "option form" for our model and contains information regarding the options of DMs, each DM's strategy, and all the developed states, each represented by a number in the last row of the table. In the table, "Y" (i.e., yes) means that a DM selected the option, and likewise "N" (i.e., no) reflects that the DM has not chosen the option.

States that are deemed to be unreasonable or unlikely to occur have been systematically eliminated from the model. As stated in Chapter 3, mutually exclusive options refer to combinations of options that are logically infeasible outcomes. In this model, the possibility of the simultaneous occurrence of options 1 and 2, 1 and 4, or 1 and 3 is deemed to be impossible (Appendix B). The first combination (i.e., simultaneous occurrence of options 1 and 2) indicates that President Obama would not approve the proposal, but would request major modification. The second and third combinations (i.e., occurrence of options 1 and 4) are also logically infeasible because if President Obama approves the Keystone XL project, the Canadian Coalition would not deny the project or send a major portion of bitumen to Asia; rather, it would construct the pipeline as TransCanada proposed in May 2012.

Another method for ruling out infeasible states is to directly specify the infeasible combinations. For example, in the model proposed here, if the Canadian Coalition selects option 4, option 3 has also been selected. This means that if the Canadian Coalition has decided to

diversify to Asian markets, it must have denied the project and, thus, option 3 has to be chosen. Using these systematic elimination methods, 28 feasible states remain and are listed in Table 4.2.

As described in Chapter 3, some of the feasible states have the potential to be intermediary states for a specific DM. For instance, in the option form provided in this chapter, state 6 is intermediary for Republicans because right after President Obama rejects the project, Republicans would increase their pressure on the president, unilaterally moving to state 13 from state 6.

State 7 could also be an intermediary state for the Republicans. One scenario is that after the US has requested modification, because of negotiations and lobbying, Republicans are convinced not to pressure President Obama to approve the project. However, in reality, Republicans have the opportunity to improve to state 14, which makes state 7 an intermediary state.

State 24 is the status quo and represents the current situation regarding this ongoing conflict. President Obama rejected the project in January 2012, declaring that his decision was due to pressure from Republicans, who assigned a deadline for making a decision regarding the project before the presidential election in November 2012. On the other hand, most environmentalists and NDEQ believe that the Keystone XL project would have serious environmental impacts, especially for areas in and surrounding Nebraska. Emphasizing the potential economic profit of the project for the US, President Obama complained that Republicans did not allow the DOS to comprehensively explore the project's environmental impacts and to help TransCanada find alternative routes to prevent possible negative effects. Through these statements, he indirectly requested modification from the Canadian Coalition. Further on, TransCanada resubmitted an alternative route to receive a presidential permit for the revised proposal. Although the Canadian

Coalition has threatened to diversify its oil sands bitumen to China if President Obama rejects the project, it has not yet made any serious attempts to execute this option.

Table 4.2: Option Form

President Obama																												
Approve	**N**	**Y**	**N**	**N**	**N**	**N**	**N**	**N**	**Y**	**N**	**N**	**N**	**N**	**N**	**N**	**Y**	**N**	**N**	**N**	**N**	**N**	**N**	**Y**	**N**	**N**	**N**	**N**	**N**
Request modification	**N**	**N**	**Y**	**N**	**Y**	**N**	**Y**	**N**	**N**	**Y**	**N**	**Y**	**N**	**Y**	**N**	**N**	**Y**	**N**	**Y**	**N**	**Y**	**N**	**N**	**Y**	**N**	**Y**	**N**	**Y**
Canadian Coalition																												
Deny Modification	**N**	**N**	**N**	**Y**	**Y**	**Y**	**Y**	**N**	**N**	**N**	**Y**	**Y**	**Y**	**Y**	**N**	**N**	**N**	**Y**	**Y**	**Y**	**Y**	**N**	**N**	**N**	**Y**	**Y**	**Y**	**Y**
Diversify	**N**	**N**	**N**	**N**	**N**	**Y**	**Y**	**N**	**N**	**N**	**N**	**N**	**Y**	**Y**	**N**	**N**	**N**	**N**	**N**	**Y**	**Y**	**N**	**N**	**N**	**N**	**N**	**Y**	**Y**
Republicans																												
Pressure to approve	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
NDEQ																												
Pressure to solve or stop	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
State Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**

4.1.3. DMs' Preferences

After identifying DMs and their options, feasible states are ordinally ranked from the most to the least preferred (from left to right) for each DM, as illustrated in Table 4.3. Equally preferred states are indicated by a line drawn on top of the numbers. Rankings of the states are based on DMs' preferences and are determined through a subjective process of studying and assessing the conflict's various aspects. Preference identification is a necessary step to achieve a more accurate analysis of the strategic conflict.

President Obama's priority is approving the operation of the pipeline (i.e., choosing option 1); therefore, states 2, 16, 9, and 23 are the scenarios that are most preferred by the US president. State 3 has been identified as a second priority for President Obama because it refers to the situation where he has requested modification, while the Canadian Coalition has not denied this request and there is no pressure from influential DMs. Least preferred states for President Obama occur when the Canadian Coalition denies modification and also diversifies bitumen to Asia.

As described earlier, the Canadian Coalition's priority is for the project to gain approval from President Obama. However, if Canada receives a modification request, it could have a chance to lobby the US to proceed toward approving the project. Pressure from the NDEQ is not favorable for Canada because the Canadian Coalition believes that construction of the pipeline is a reasonable way to reduce GHG emissions compared to transporting oil sands bitumen by truck. Several problems, such as leakage in some sections of the pipeline and the energy needed to heat huge amounts of water, have created serious concerns about approval of the Keystone XL project (Cryderman, 2013). This has led NDEQ to oppose approval despite the other three DMs'

preferences. If President Obama rejects the project and the Canadian Coalition decides to deny modification, it is preferable for Canada to diversify its oil sands bitumen rather than do nothing.

In contrast, Republicans strongly support approval of the project. One of their stated priorities in the 2012 presidential election was proceeding with construction of the pipeline. Republicans' viewpoint regarding economic development and less dependency on Middle Eastern countries for importing energy is consistent with President Obama's opinion. This is why the ranking of Republicans' preferences is somewhat similar to President Obama's preference alignment. For example, both Democrats' and Republicans' least preferred states are 7, 14, 21, and 28. However, in some situations, the order of state ranking differs for each party. For example, Republicans favor pressuring President Obama, while this issue is not preferred from his perspective.

Table 4.3: Ranking the Preferences of DMs from the Most (Left) to Least (Right)

DMs	Ranking of States																											
President Obama	2	3	16	9	23	17	10	24	1	15	8	22	4	18	11	25	6	20	13	27	5	19	12	26	7	21	14	28
Canadian Coalition	2	9	23	16	10	3	24	17	14	7	28	21	12	5	19	26	13	6	27	20	8	1	11	4	22	15	25	18
Republicans	9	23	2	16	10	24	3	17	8	22	1	15	11	25	4	18	13	27	6	20	12	26	5	19	14	28	7	21
NDEQ	15	18	20	22	25	27	1	8	4	6	11	13	21	19	28	26	12	5	7	14	17	24	3	10	16	23	2	9

4.2. Representing the Strategic Conflict Using Standard Graph Form for the New Model

Figure 4.2 shows the integrated graph model for the Keystone XL strategic conflict in the new model proposed in this chapter. Republicans, represented as DM3, could improve from state 6 to state 13. NDEQ, indicated by DM4, could have a UI from state 6 to state 20. President Obama and the Canadian Coalition could also unilaterally move from state 6. All in all, DMs only control their own option changes leading to transitions from one state to another. For example, in the transition between state 6 and state 7, only President Obama has changed his strategy, while other DMs' strategies have not been altered.

4.3. Stability Analysis of the Keystone XL Strategic Conflict Based on the Graph Model

In this part, since the model has changed compared to the constructed model in Chapter 3, a standard stability analysis has been conducted by means of comparison with the perceptual graph model. Table 4.4 is the tableau form of the graph model and contains individual preferences from the most to the least (left to right) preferred, their UIs, and individual stability for all DMs. Also, overall stability, indicated at the top of Table 4.4, shows states that are stable for all DMs (i.e., equilibrium states).

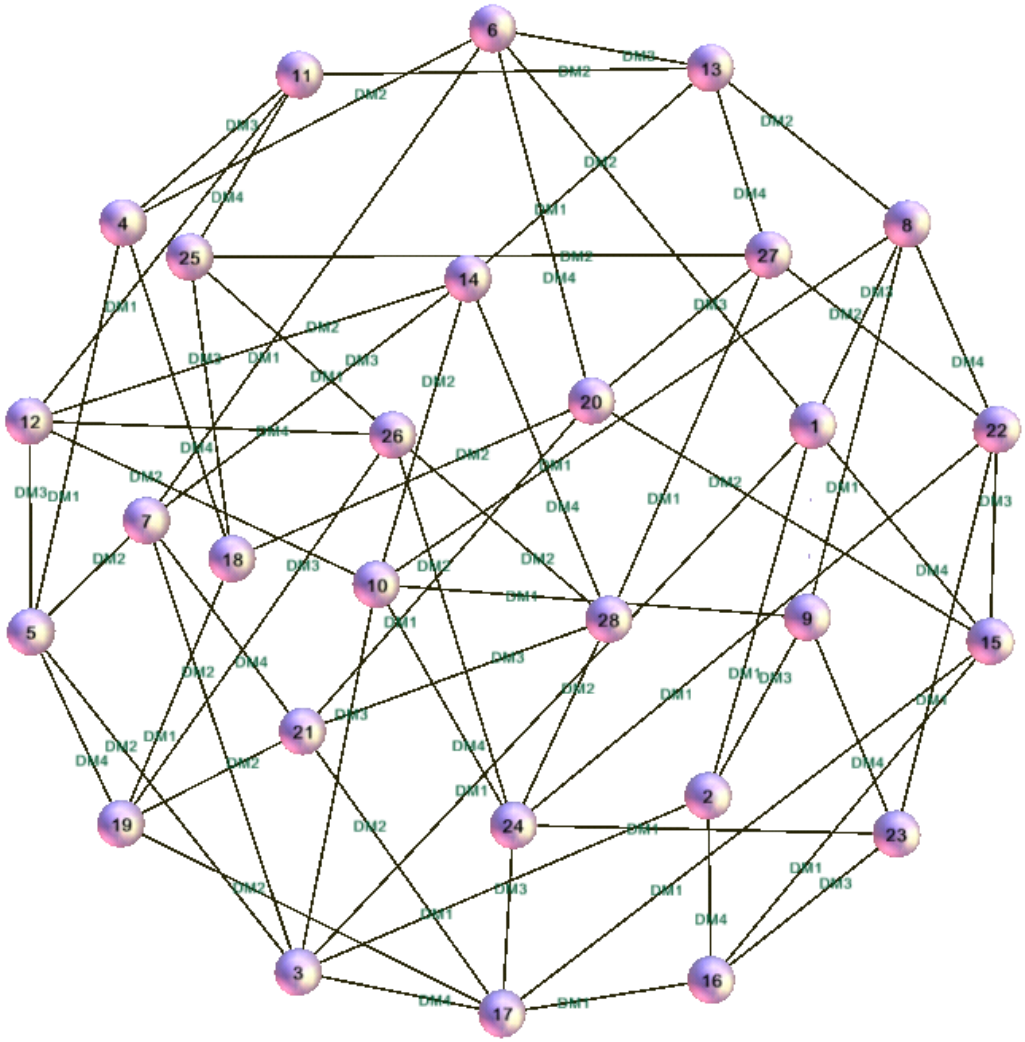

Figure 4.2: Integrated Graph Form;

DM1: President Obama, DM2: Canadian Coalition, DM3: Republicans, DM4: NDEQ. Note: The relations between the arcs are all bidirectional.

Table 4.4: Stability Analysis tableau form for the Keystone XL Pipeline Strategic Conflict

President Obama																												
Overall stability	X	X	X	X	E	X	X	X	X	X	X	X	X	X	X	X	X	X	X	E	X	X	X	X	X	X	X	X
Player stability	R	S	R	R	R	U	U	U	U	U	U	U	R	R	R	R	R	R	R	R	U	U	U	U	U	U	U	U
Preference vector	2	3	16	9	23	17	10	24	1	15	8	22	4	18	11	25	6	20	13	27	5	19	12	26	7	21	14	28
UIs		2				16	9	23	2	16	9	23									4	18	11	25	6	20	13	27
									3	17	10	24																
Canadian Coalition																												
Player stability	R	R	R	R	R	R	R	R	U	U	U	U	S	S	S	S	R	R	R	R	U	U	U	U	U	U	U	U
Preference vector	2	9	23	16	10	3	24	17	14	7	28	21	12	5	19	26	13	6	27	20	8	1	11	4	22	15	25	18
UIs									10	3	24	17	10	3	17	24					13	6	13	6	27	20	27	20
													14	7	21	28												
Republicans																												
Player stability	R	R	U	U	R	R	U	U	R	R	U	U	R	R	S	S	R	R	U	U	R	R	U	U	R	R	U	U
Preference vector	9	23	2	16	10	24	3	17	8	22	1	15	11	25	4	18	13	27	6	20	12	26	5	9	14	28	7	21
UIs			9	23			10	24			8	22			11	25			13	27			12	26			14	28
NDEQ																												
Player stability	R	R	R	R	R	R	S	S	U	U	U	U	R	R	R	R	U	U	U	U	R	R	S	S	R	R	U	U
Preference vector	15	18	20	22	25	27	1	8	4	6	11	13	21	19	28	26	12	5	7	14	17	24	3	10	16	23	2	9
UIs							15	22	18	20	25	27					26	19	21	28			17	24			16	23

GMCRII, a decision support system, was used to conduct stability analysis to determine stable and unstable states based on a set of solution concepts, which are explained in Table 3.6, Chapter 3 (Appendix B). According to Table 4.4, state 2 is the most preferred state for President Obama and the Canadian Coalition. Thus, state 2 is rational (i.e., "R") and satisfies Nash stability for both DMs. State 1 is unstable (i.e., "U") for President Obama since he may choose to move to other states such as state 2 or state 3, which he prefers to state 1. State 4 is sanctioned (i.e., "S") for Republicans by other DMs. This means that if Republicans improve to state 11 from state 4, NDEQ would improve to state 25 and the Canadian Coalition would unilaterally move to state 27, which is Nash stable for President Obama. However, state 27 is less preferred than state 4 for Republicans. This means that, despite the initial intention of Republicans to improve from state 4 to a better state, the consequence of the mentioned unilateral improvement may not be in Republicans' favor since it gives other DMs the opportunity to unilaterally improve to stable states that are less preferred for Republicans than state 4.

Based on solution concepts' definitions, as indicated in Table 4.5 and Table 4.6, states 23 and 27 are stable for all DMs (i.e., equilibrium states). The mentioned states satisfy all rules or solution concepts and are represented by "E." The states that are stable for some but not all DMs are shown by "X" in Table 4.4 (Appendix B).

Table 4.5: Equilibria

States / Solution Concepts	23	27
Nash Equilibrium	✓	✓
GMR	✓	✓
SMR	✓	✓
SEQ	✓	✓

Both equilibrium states represent enforcement from influential DMs. Republicans try to push President Obama to move toward approval of the Keystone XL pipeline, while NDEQ insists that the environmental concerns should be resolved before granting approval for the project. State 27 indicates that President Obama rejects the project under pressure from NDEQ. In this state, the Canadian Coalition would not insist on continuing the project and, thus, would deny modification and diversify large amounts of its oil sands bitumen to Asia. However, state 23 represents the situation in which President Obama directly approves the proposal and becomes Canada's main customer. However, even in this condition, requesting some minor modifications is still probable. President Obama requesting minor modifications from the Canadian Coalition may appease NDEQ and other moderate environmentalists to some extent.

Interestingly, the resulting equilibrium states in this chapter are similar to the results of the primary model proposed in Chapter 3. This issue demonstrates the relatively high robustness of the developed models in this study. As shown in Table 4.6, state 27 in the current model is similar to state 19 in the previous model from Chapter 3. In state 27, the Canadian Coalition will stop insisting on the project's approval and diversify the main portion of bitumen to Asia. On the other hand, state 19 in the previous model shows Canada's intention to diversify oil sands bitumen when the project is rejected by President Obama. State 21 in the original model and state 23 in the current model are also similar. Both indicate that President Obama will approve the project. In the former model, the Canadian Coalition chooses option 3 (i.e., build the pipeline). The latter model indicates that after the project has been approved, the Canadian Coalition would not diversify high amounts of oil sands bitumen to Asia. Also, not denying modification after the project has been approved by President Obama means that the Canadian Coalition is consenting to the construction of TransCanada's proposed route from May 2012.

Table 4.6: Comparison of the Equilibria States in Chapter 3 and Chapter 4

Model Proposed in This Chapter			Model Proposed in Chapter 3		
State Numbers	23	27		19	21
President Obama			President Obama		
1- Approve	Y	N	1- Approve	N	Y
2- Request Modification	N	N	2- Request Modification	N	N
Canadian Coalition			Canadian Coalition		
3- Deny Modification	N	Y	3- Build	N	Y
4- Diversify	N	Y	4- Modify	N	N
Republicans			Republicans		
5- Pressure to Approve	Y	Y	5- Pressure to Approve	Y	Y
NDEQ			NDEQ		
6- Pressure to Solve or Stop	Y	Y	6- Pressure to Solve or Stop	Y	Y

4.4. Perceptual Graph Model for the Keystone XL Pipeline Conflict

In the standard graph model technique section outlined above, the conflict was modeled and analyzed. The methodology was exactly the same as the technique used in Chapter 3. Modeling of the perceptual graph model technique is also similar to this process. Determining DMs, their options, feasible states, and state rankings based on DMs' preferences are primary steps in the perceptual graph model technique. In the first step of perceptual stability analysis, hidden states for each of the DMs are identified. Then, based on each DM's awareness of whether other DMs can or cannot see all the states in its own graph model and with the help of particular perceptual solution concepts, individual and overall stable states are determined.

4.4.1. Hidden and Recognized States

Due to existing negative emotions such as fear and anger, a DM would not consider or be aware of certain states. These states are invisible in this DM's point of view and are called hidden states. The criticality of recognizing and studying a conflict's hidden states becomes evident in the case of serious tensions between two or more parties. Although there are no highly elevated negative emotions among the DMs in the conflict over the Keystone XL project, the perceptual graph model can be used to analyze this friendly dispute with different, though interesting, perspectives. For this purpose, the least preferred states for each DM are assumed to be hidden in that particular DM's point of view. The aim is to apply the perceptual graph technique to analyze each DM's perceptual graph based on his or her own awareness regarding others' strategies.

The remaining set of states that DMs perceive are known as recognized states. Table 4.7 lists hidden states in each DM's point of view. For example, states 7, 14, 21, and 28 are assumed to be hidden in President Obama's perspective. They represent the situation where President

Obama requests modification but the Canadian Coalition denies it and diverts the main portion of Canada's bitumen to Asia. These states are least preferred for President Obama since they reflect the image of an incapable president of a powerful country. Before requesting modification, President Obama prefers to negotiate with the Canadian Coalition to convince its members that the proposed route has environmental problems that must be resolved. Moreover, he tries to prevent the Canadian Coalition from selling its oil sands bitumen to Asian markets. Since shipping oil sands bitumen to Asia is not at all a favorable outcome for the US, President Obama would try to avoid these states at all cost, making them hidden in his perspective. Consequently, all the mentioned feasible states are recognized by President Obama except states 7, 14, 21, and 28.

Although Republicans are concerned about the pride of their country and the above mentioned states (i.e., states 7, 14, 21, and 28) are least preferred in their eyes as well, they are in serious political competition with the Democratic Party. Therefore, these states have not been considered as hidden for Republicans since their concern is lower than President Obama's wariness regarding the situation where states 7, 14, 21, and 28 are attained. For the reason outlined above, Republicans perceive all feasible states of the proposed model and have no hidden states in their perspective.

Table 4.7: Hidden or Least preferred States for Each DM's Point of View

DMs	Hidden States
President Obama	7, 14, 21, 28
Canadian Coalition	15, 18, 22, 25
Republicans	-
NDEQ	2,9

States 15, 18, 22, and 25 represent the situation in which President Obama rejects the project but the Canadian Coalition does not diversify its oil to Asia. In states 15 and 22, Canada does not deny modification, but in states 18 and 25 it does. These are hidden states for Canada since they convey a worldwide image of Canada as incapable. The US has requested modifications many times and once even rejected the proposal. Canada, on the other hand, has always been patient in submitting revised proposals. However, it has not shown signs of patience in statements regarding the probability of President Obama rejecting the most recent proposal. If the US rejects the proposal, Canada would most probably diversify its oil to Asian markets to show the US and the world that Canada is not solely dependent on the US. For the above reasons, Canada does not perceive that these four states (i.e., US rejects the proposal and Canada does not diversify its oil to Asian markets) can occur in the real world, making them hidden states in the eyes of this DM.

As shown in Table 4.7, states 2 and 9 are assumed to be hidden states in NDEQ's point of view. Both states represent the condition where despite President Obama's approval of the Keystone XL project, NDEQ is not pressuring him to stop the project or resolve its environmental impacts. Thus, NDEQ does not perceive the mentioned states as possible to occur.

NDEQ fears that the project will severely endanger the environment. Therefore, if it does not pressure President Obama, it will be put in the spotlight for not acting against this tragedy. Because of this fear, the two mentioned states do not have the chance to occur and are hidden in the view of NDEQ.

4.5. Perceptual Graph Forms

Figure 4.3 shows President Obama's perceptual graph form. President Obama's hidden states with their relative arcs are shown as white nodes and dimmed arcs. For instance, since state 28 is hidden in the eyes of President Obama, he would not see the possibility of unilaterally improving to state 27 or other DMs unilaterally moving to states 14, 21, 24, or 26.

Figure 4.4 is the Canadian Coalition's perceived graph form. As shown, states 15, 18, 22, and 25 are hidden in its viewpoint. Therefore, all the transitions passing through the mentioned states are dimmed. Since this study has assumed that Republicans have perceived all the feasible states, their integrated graph form is the same as the standard graph form shown in Figure 3.1. Figure 4.5 is NDEQ's perceptual integrated graph form in which it does not perceive states 2 and 9.

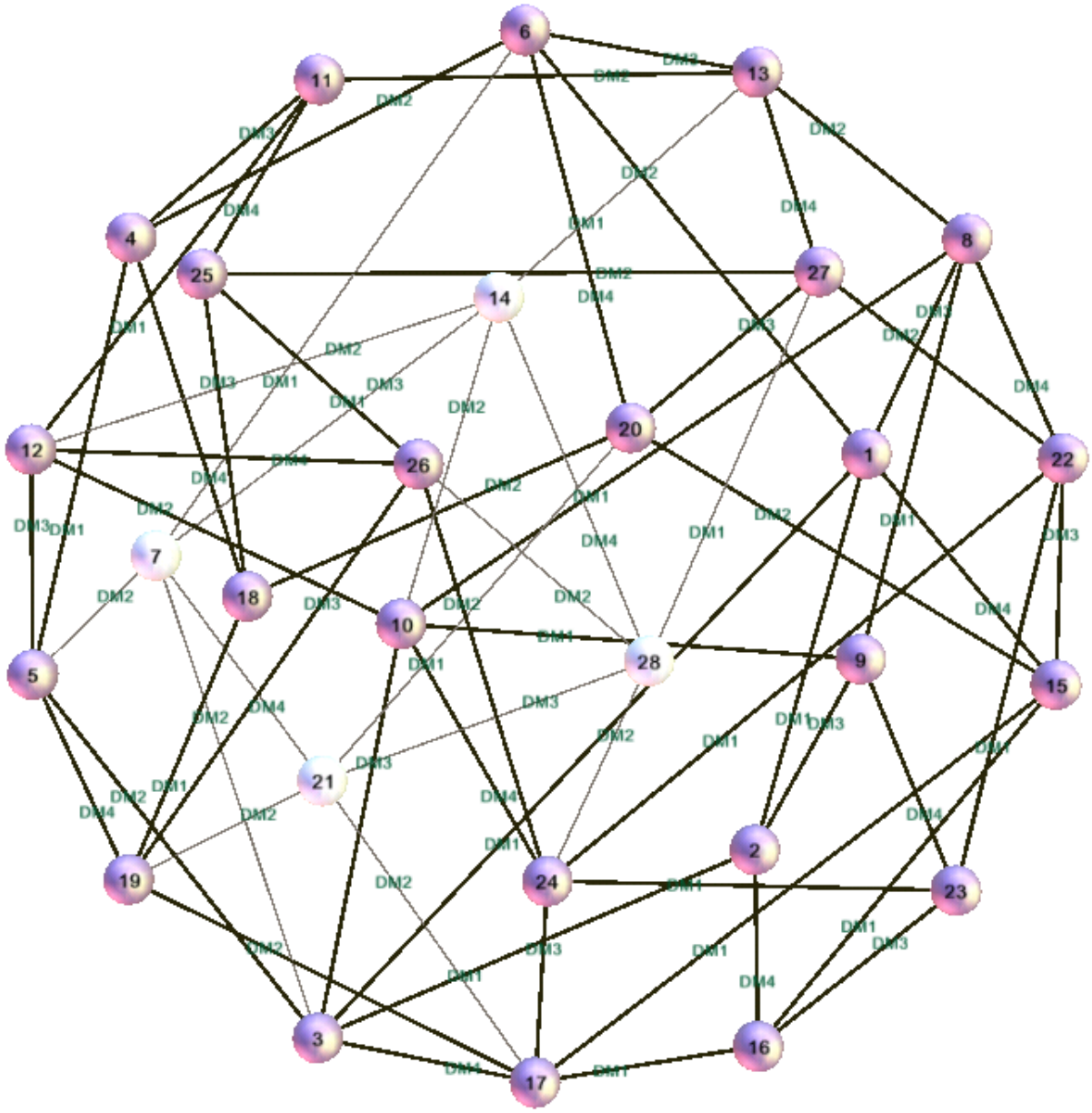

Figure 4.3: President Obama's Perceptual Graph Form;

DM1: President Obama, DM2: Canadian Coalition, DM3: Republicans, DM4: NDEQ. Note: The relations between the arcs are all bidirectional.

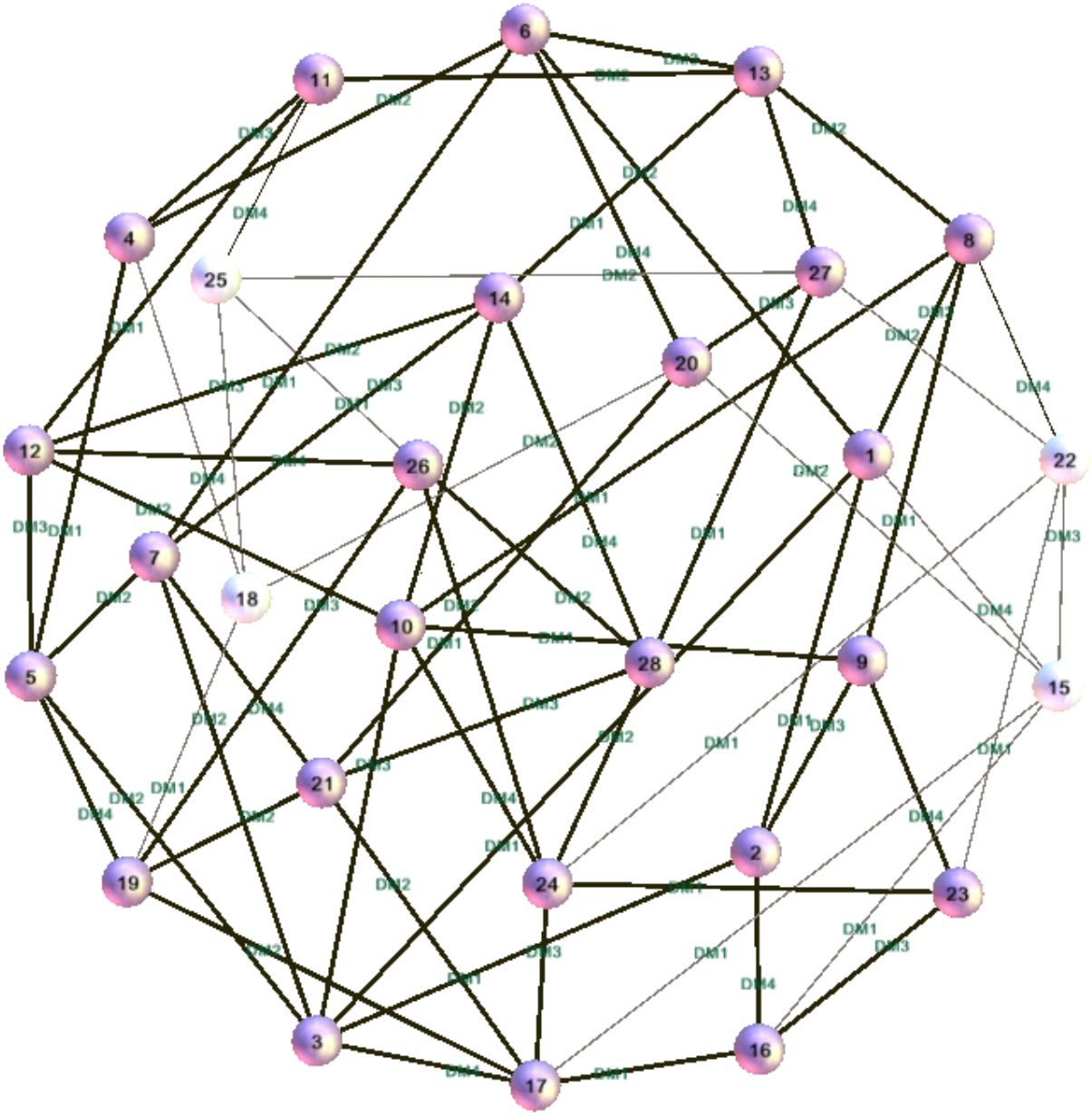

Figure 4.4: Canadian Coalition's Perceptual Graph Form;

DM1: President Obama, DM2: Canadian Coalition, DM3: Republicans, DM4: NDEQ. Note: The relations between the arcs are all bidirectional.

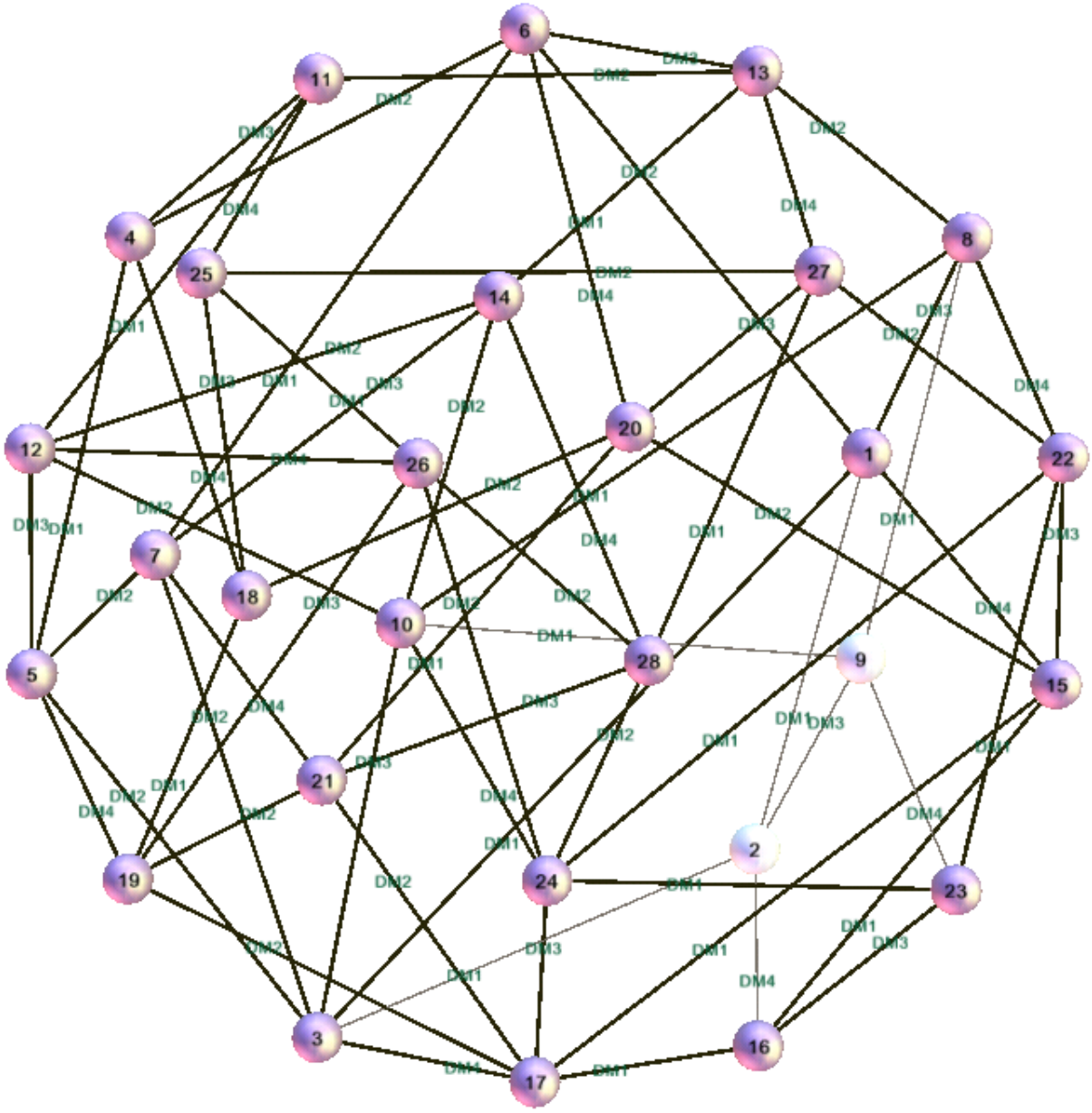

Figure 4.5: NDEQ's Perceptual Graph Form;

DM1: President Obama, DM2: Canadian Coalition, DM3: Republicans, DM4: NDEQ. Note: The relations between the arcs are all bidirectional.

4.6. Perceptual Stability Analysis

One of the key components of the perceptual graph model technique is consideration of the awareness of each DM regarding other DMs' strategies. Drawing on DMs' recognized and hidden states and particular solution concepts defined in Appendix B, perceptual stability analysis is conducted for each DM to form separate private and overall sets of stable states. Assuming that *k* is a particular DM, $\alpha_k = 1$ represents a situation in which that particular DM is aware of other DMs' perceptions. On the other hand, $\alpha_k = 0$ denotes the condition where the DM is not aware of other DMs' strategies.

4.6.1. Perceptual Solution Concepts

Nash, GMR, SMR and SEQ, as defined in Table 3.6 of Chapter 3, are important solution concepts that are used in both standard and perceptual graph model techniques. In addition to these four widely accepted solution concepts, Table 4.8 lists other rules needed for analyzing the proposed model based on the perceptual graph technique. DMs' options and strategies have been assessed separately based on these seven solution concepts and also in regard to each DM's awareness status.

Table 4.8: Perceptual Solution Concepts in Addition to Nash, GMR, SMR and SEQ (Also descriibed in Appendix B) (Obeidi et al., 2009)

Solution Concepts	Descriptions
Stability by Default (Default)	"where the focal DM *i* has no option to accept the current state because there exists no adjacent state that *i* can move to. Note that DM *k* assesses the reachable list, *Ri*(*s*), for the focal DM*i* that is located in *Sk*. A special case occurs when DM *k* is aware of some adjacent states that are invisible to focal DM *i*. Hence, *k* knows that the current state appears to be default stable for DM *i*, although in reality it is not". If a focal DM cannot unilaterally move from current state, the state by default is stable for that DM.
Apparent Default Stability (A Default)	If a focal DM cannot unilaterally move from current state, because the DM's perceptions of his/her own possible moves are limited the state is apparently default stable for that DM. Therefore, "A default" stability is not considered for the owner of the perceptual graph model when the DM is aware of other DMs' perceptions.

Apparently Perceived Nash Stability (A Nash)	"Although DM *i* can move unilaterally from the current state, all UIs are apprehended by DM *j* but not by the focal DM *I* whose perception is limited. Note that apparent Nash stability does not apply to the focal DM who owns the graph model, since DM *i*'s awareness would be equal to DM *k*'s. Therefore, apparent stability applies only for a focal DM with limited perception".

4.7. Meta-Stability Analysis

The results of the individual perceptual stability analysis depend highly on the awareness status of the focal DM. After each DM's individual stability analysis has been conducted through the use of standard and perceptual solution concepts, a meta-stability analysis would be implemented. In this second phase, the private and overall stabilities are consolidated, which provides a thorough understanding of the conflict. Concepts such as stationary equilibrium, transitory equilibrium, stationary pseudo-equilibrium, and transitory pseudo-equilibrium, which are defined in Section 4.6.1 and summarized in Table 4.9, are used to conduct meta-stability analysis in phase two of the perceptual stability analysis.

Table 4.9: Properties of Meta-Stability Analysis under Variants of Awareness and Perception

	In some but not all variants of awareness	In all variants of awareness
Perceived by all DMs	Transitory Equilibrium	Stationary Equilibrium
Perceived by some but not all DMs	Transitory Pseudo-Equilibrium	Stationary Pseudo-Equilibrium

4.7.1. Standard or Stationary Equilibrium

Similar to the standard graph model technique, states that are stable for all DMs are standard equilibria. However, overall stable states must be recognized by all DMs in the conflict in perceptual graph model analysis; these states describe the most robust resolutions that satisfy all solution concepts under all variants of awareness.

4.7.2. Transitory Equilibrium

If a state is perceived by all DMs and satisfies particular solution concepts under some variants of awareness, that state will be labeled as a transitory equilibrium.

4.7.3. Stationary Pseudo-Equilibrium

Pseudo-equilibrium occurs when a state is not recognized by all DMs, but is stable under particular solution concepts for some DMs who perceive it. These states are not sustainable resolutions because some DMs do not recognize them. Although a pseudo-equilibrium state tends to satisfy only short-term resolutions of the conflict, it could turn into a long-term outcome if the DMs who perceive it insist on staying in that situation and not moving away from it.

4.7.4. Transitory Pseudo-Equilibrium

The definition of this kind of equilibrium is similar to that of stationary pseudo-equilibrium. The only difference is that transitory pseudo-equilibrium is defined only in some variants of awareness, while stationary pseudo-equilibrium considers all variants of awareness. In other words, a state can be a stationary pseudo-equilibrium when the DM is both aware and not aware of others' perceptions. However, this state would be considered as a transitory pseudo-equilibrium if the DM is either aware or not aware (but not both) of other DMs' perceptions.

4.8. Perceptual Stability Analysis and the Keystone XL Pipeline Strategic Conflict

Now this study proceeds to implementing the perceptual graph model technique to analyze the Keystone XL pipeline dispute. As shown in Figure 4.6, the circles represent state numbers. Recognized states have been shown by (P_R). Since Republicans perceive all the recognized states, these states are also representative of Republicans' perceived states. The Canadian Coalition recognizes all states except states 15, 18, 22, and 25. The mentioned states are assumed to be hidden for the Canadian Coalition and are presented as (H_C) in Figure 4.6. Moreover, the Canadian Coalition's perceived states are shown by (P_C) in that $P_R - H_C = P_C$. Hidden states in President Obama's viewpoint are represented as (H_O) and NDEQ's hidden states are presented as (H_N). Also, states that are perceived or recognized by President Obama are shown by (P_O) and NDEQ's recognized states have been indicated by (P_N).

Figure 4.7 represents President Obama's awareness regarding other DMs' viewpoints. When $\alpha = 1$, President Obama is aware of the Canadian Coalition's and NDEQ's recognized and hidden states. Therefore, in this scenario, President Obama is aware that the Canadian Coalition does not see states 15, 18, 22, and 25 and that NDEQ does not see states 2 and 9. The

Canadian Coalition's and NDEQ's hidden states have been written in gray (as opposed to black). As mentioned earlier, states 7, 14, 21, and 28 are hidden in President Obama's point of view and, thus, have been removed from President Obama's perceptual graph model in Figure 4.7.

If President Obama is not aware ($\alpha = 0$) of other DMs' perceptions, these DMs' hidden states would be present and considered in President Obama's perceptual graph model. Since all states are recognized by Republicans, they do not affect other DMs' perceptual graph models in different awareness circumstances.

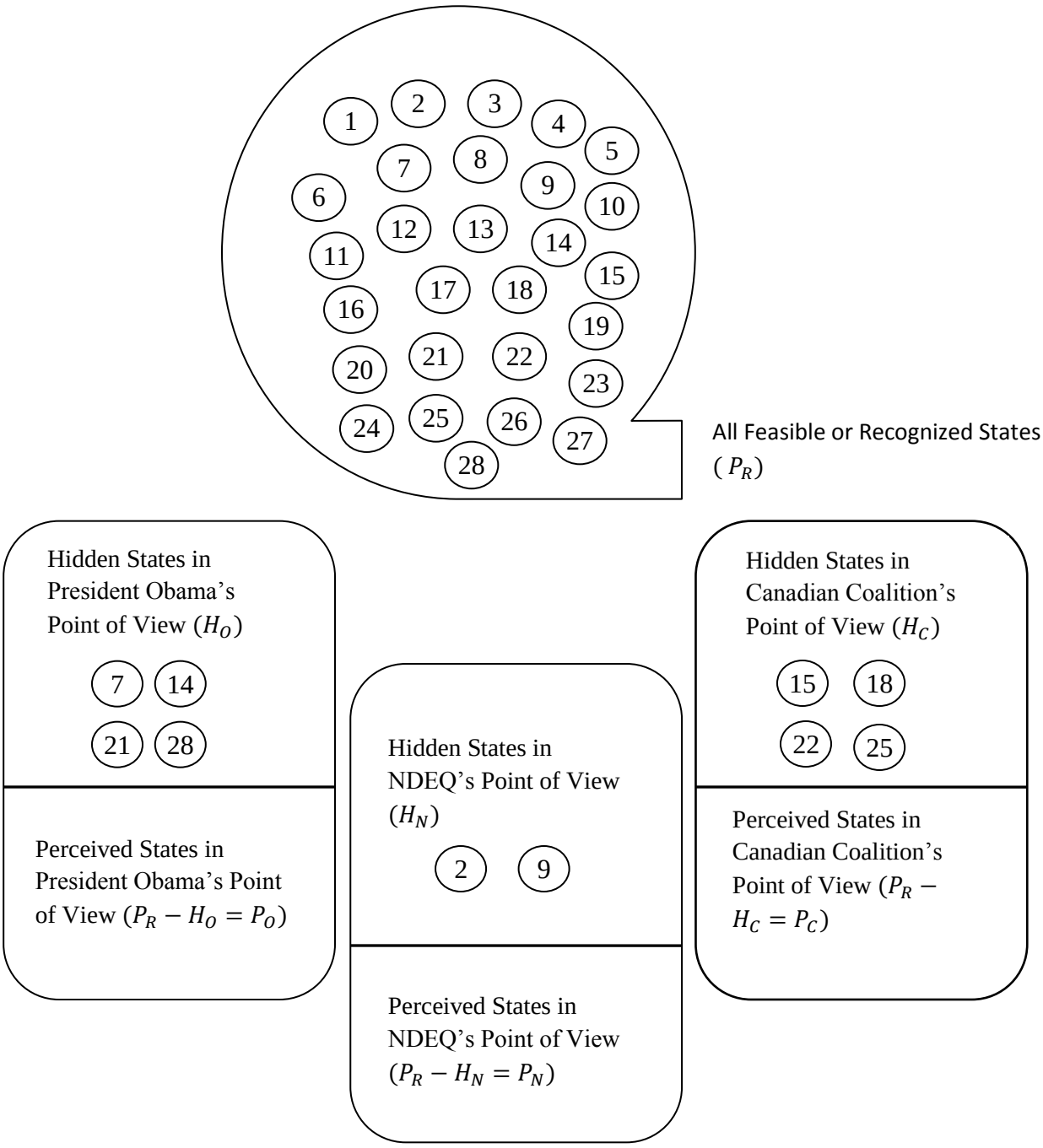

Figure 4.6: Set of Hidden and Recognized States for DMs

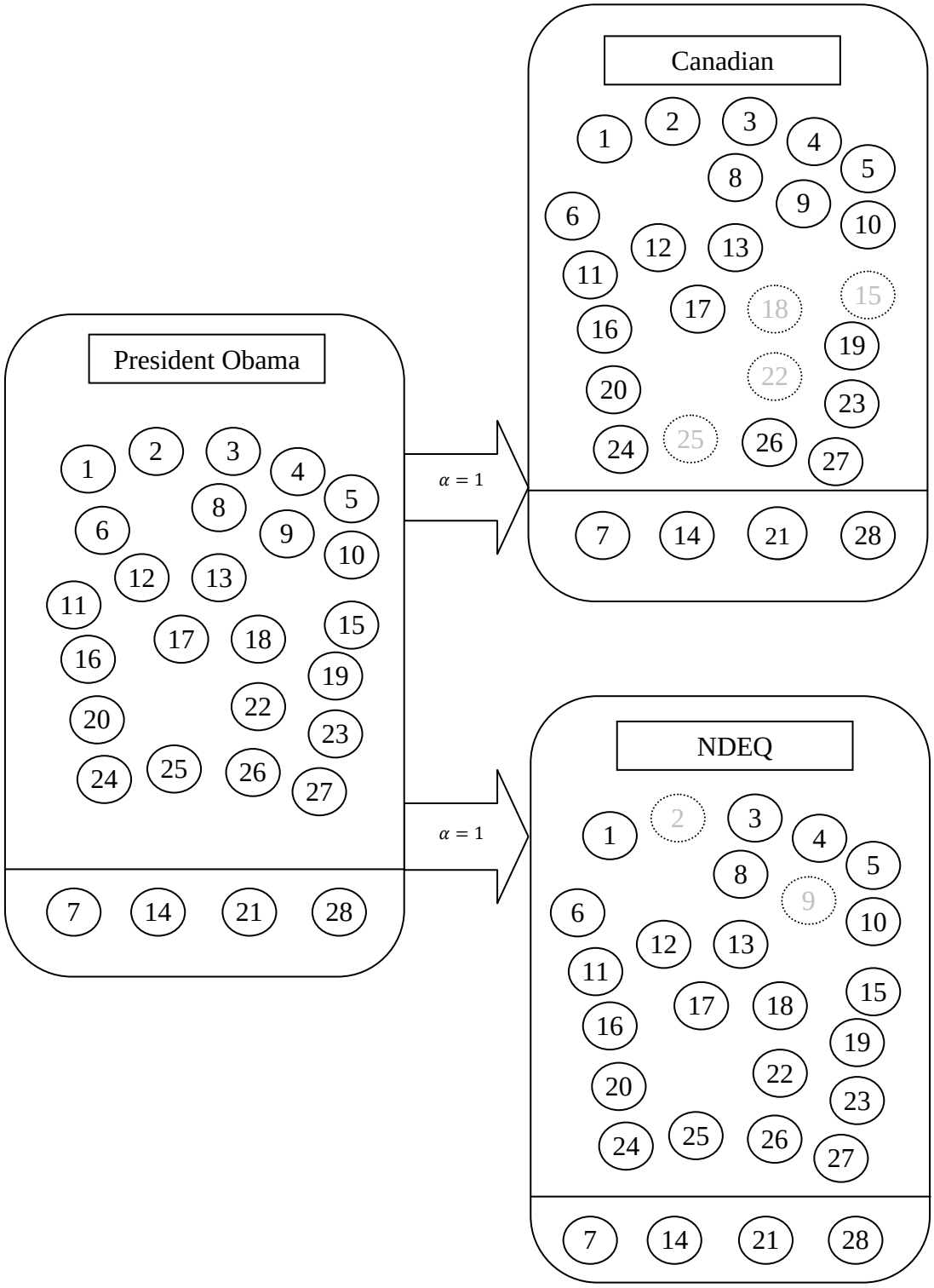

Figure 4.7: President Obama's Awareness Regarding Other DM's Perceptions;

When $\alpha = 1$, he is aware that Canadian Coalition does not see states 15, 18, 22, 25. Also, he knows that NDEQ does not see states 2 and 9. States 7, 14, 21, and 28 are not perceived by President Obama himself.

Tables 4.10 and 4.11 are perceptual graphs in terms of President Obama's point of view toward the Keystone conflict. States that are not perceived by President Obama have been highlighted in gray. In the former table, he is aware ($\alpha = 1$) that other DMs do not see some particular states, while in the latter table he does not perceive other DMs' hidden states ($\alpha = 0$).

In standard graph model, President Obama can unilaterally move from state 6 to state 7. However, since in perceptual graph model state 7 is a hidden state in President Obama's point of view, he would stay in state 6. State 6 is considered as default stable for President Obama and thus, there is no need to assess this state under the remaining solution concepts. State 13 is also a default stable state for President Obama since he does not perceive state 14 as a recognized state and, thus, does not move away from state 13 to state 14. The cells that contain a forward slash represent the states that have not been assessed.

State 20 is apparently default stable for the Canadian Coalition in Table 4.10. Since President Obama is aware that the Canadian Coalition does not perceive state 15, in his point of view, Canada would not move from state 20 to state 15. Therefore, state 20 becomes apparently default stable for the Canadian Coalition in President Obama's viewpoint.

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Table 4.10: Stability Analysis Based on Perceptual Graph Model Technique in President Obama's Point of View (α=1)

President Obama's viewpoint (α=1)		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
President Obama	Default	N	N	N	N	N	Y		N	N	N	N	N	Y		N	N	N	N	N	Y		N	N	N	N	N	Y	
	A Default	/	/	/	/	/	/		/	/	/	/	/	/		/	/	/	/	/	/		/	/	/	/	/	/	
	Nash	N	Y	N	Y	N	/		N	Y	N	Y	N	/		N	Y	N	Y	N	/		N	Y	N	Y	N	/	
	A Nash	/	/	/	/	/	/		/	/	/	/	/	/		/	/	/	/	/	/		/	/	/	/	/	/	
	GMR	N	Y	SAUN	Y	N	/		N	Y	N	Y	N	/		N	Y	N	Y	N	/		N	Y	N	Y	N	/	
	SEQ	N	Y	SAUN	Y	N	/		N	Y	N	Y	N	/		N	Y	N	Y	N	/		N	Y	N	Y	N	/	
	SMR	N	Y	Y	Y	N	/		N	Y	N	Y	N	/		N	Y	N	Y	N	/		N	Y	N	Y	N	/	
Canadian Coalition	Default	N	Y	N	N	N	N		N	Y	N	N	N	N		/	Y	N	/	N	N		/	Y	N	/	N	N	
	A Default	N	/	N	N	N	N		N	/	N	N	N	N		/	/	N	/	N	Y		/	/	N	/	N	Y	
	Nash	N	/	Y	N	N	Y		N	/	Y	N	N	Y		/	/	Y	/	N	/		/	/	Y	/	N	/	
	A Nash	N	/	N	N	N	N		N	/	N	N	N	N		/	/	N	/	N	/		/	/	N	/	N	/	
	GMR	N	/	Y	N	N	Y		N	/	Y	N	N	Y		/	/	Y	/	N	/		/	/	Y	/	N	/	
	SEQ	N	/	Y	N	N	Y		N	/	Y	N	N	Y		/	/	Y	/	N	/		/	/	Y	/	N	/	
	SMR	N	/	Y	N	N	Y		N	/	Y	N	N	Y		/	/	Y	/	N	/		/	/	Y	/	N	/	
Republicans	Default	N	N	N	N	N	N		N	N	N	N	N	N		N	N	N	N	N	N		N	N	N	N	N	N	
	A Default	N	N	N	N	N	N		N	N	N	N	N	N		N	N	N	N	N	N		N	N	N	N	N	N	
	Nash	N	N	N	N	N	N		Y	Y	Y	Y	Y	Y		N	N	N	N	N	N		Y	Y	Y	Y	Y	Y	
	A Nash	N	N	N	N	N	N		N	N	N	N	N	N		N	N	N	N	N	N		N	N	N	N	N	N	
	GMR	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	N		Y	Y	Y	Y	Y	Y	
	SEQ	Y	N	N	Y	Y	N		Y	Y	Y	Y	Y	Y		Y	N	N	Y	Y	Y		Y	Y	Y	Y	Y	Y	
	SMR	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	N		Y	Y	Y	Y	Y	Y	
NDEQ	Default	N	/	N	N	N	N		N	/	N	N	N	N		N	N	N	N	N	Y		N	N	N	N	N	N	
	A Default	N	/	N	N	N	N		N	/	N	N	N	N		N	Y	N	N	N	N		N	Y	N	N	N	N	
	Nash	N	/	N	N	N	N		N	/	N	N	N	N		Y	/	Y	Y	Y	Y		Y	/	Y	Y	Y	Y	
	A Nash	N	/	N	N	N	N		N	/	N	N	N	N		N	/	N	N	N	N		N	/	N	N	N	N	
	GMR	Y	/	N	Y	N	Y		Y	/	Y	Y	N	Y		Y	/	Y	Y	Y	Y		Y	/	Y	Y	Y	Y	
	SEQ	Y	/	N	Y	N	N		Y	/	Y	N	N	N		Y	/	Y	Y	Y	Y		Y	/	Y	Y	Y	Y	
	SMR	Y	/	N	Y	N	Y		Y	/	Y	Y	N	Y		Y	/	Y	Y	Y	Y		Y	/	Y	Y	Y	Y	

Table 4.11: Stability Analysis Based on Perceptual Graph Model Technique in President Obama's Point of View (α=0)

President Obama's viewpoint (α=0)		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
President Obama	Default	N	N	N	N	N	Y		N	N	N	N	N	Y		N	N	N	N	N	Y		N	N	N	N	N	Y	
	Nash	N	Y	N	Y	N	/		N	Y	N	Y	N	/		N	Y	N	Y	N	/		N	Y	N	Y	N	/	
	GMR	N	Y	Y	Y	N	/		N	Y	N	Y	N	/		N	Y	N	Y	N	/		N	Y	N	Y	N	/	
	SEQ	N	Y	Y	Y	N	/		N	Y	N	Y	N	/		N	Y	N	Y	N	/		N	Y	N	Y	N	/	
	SMR	N	Y	Y	Y	N	/		N	Y	N	Y	N	/		N	Y	N	Y	N	/		N	Y	N	Y	N	/	
Canadian Coalition	Default	N	Y	N	N	N	N		N	Y	N	N	N	N		N	Y	N	N	N	N		N	Y	N	N	N	N	
	Nash	N	/	Y	N	N	Y		N	/	Y	N	N	Y		N	/	Y	N	N	Y		N	/	Y	N	N	Y	
	GMR	N	/	Y	N	N	Y		N	/	Y	N	Y	Y		N	/	Y	N	N	Y		N	/	Y	N	Y	Y	
	SEQ	N	/	Y	N	N	Y		N	/	Y	N	N	Y		N	/	Y	N	N	Y		N	/	Y	N	N	Y	
	SMR	N	/	Y	N	N	Y		N	/	Y	N	Y	Y		N	/	Y	N	N	Y		N	/	Y	N	Y	Y	
Republicans	Default	N	N	N	N	N	N		N	N	N	N	N	N		N	N	N	N	N	N		N	N	N	N	N	N	
	Nash	N	N	N	N	N	N		Y	Y	Y	Y	Y	Y		N	N	N	N	N	N		Y	Y	Y	Y	Y	Y	
	GMR	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	
	SEQ	Y	N	N	Y	Y	N		Y	Y	Y	Y	Y	Y		Y	N	N	Y	Y	N		Y	Y	Y	Y	Y	Y	
	SMR	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	
NDEQ	Default	N	N	N	N	N	N		N	N	N	N	N	N		N	N	N	N	N	N		N	N	N	N	N	N	
	Nash	N	N	N	N	N	N		N	N	N	N	N	N		Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	
	GMR	Y	N	Y	Y	Y	Y		Y	N	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	
	SEQ	Y	N	Y	N	Y	N		Y	N	Y	N	Y	N		Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	
	SMR	Y	N	Y	Y	Y	Y		Y	N	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	

According to Table 4.10, states 9, 23, 25, and 27 are overall stable under Nash, GMR, SMR, and SEQ solution concepts. However, as revealed by perceptual graph model solution concepts, states 9 and 25 are transitory pseudo-equilibrium states when President Obama is aware of other DMs' perceived states in Table 4.10. State 9 represents the situation where President Obama approves the project under Republicans' pressure, but NDEQ does not pressure him about this decision. Moreover, state 25 describes the condition where President Obama rejects the project, while the Canadian Coalition stops insisting on its approval, but does not diversify its oil sands bitumen to Asian markets. As mentioned earlier, state 9 is a hidden state for NDEQ and state 25 is a hidden state for the Canadian Coalition. Therefore, the conclusion that states 9 and 25 are stable states may mislead President Obama in making decisions regarding the other DMs.

As shown in Table 4.10, President Obama perceives state 3 as GMR and SEQ strategic advantage unstable (SAUN). According to the standard graph model summarized in Table 4.3, if President Obama is not aware of NDEQ's recognized states, he would not know that state 2 is a hidden state in NDEQ's perspective. In this case ($\alpha = 0$ for President Obama), he would be worried to move from state 3 to state 2 since he thinks that he would be sanctioned by NDEQ. However, if President Obama is aware of NDEQ's hidden states, he could improve to state 2 without any concern of sanctions from NDEQ. Moreover, in Table 4.10, state 18 is stable under all solution concepts for all DMs, except Nash stability for Republicans; thus, this state is a transitory equilibrium in President Obama's perspective.

In Table 4.11, since state 7 is hidden for President Obama and, thus, he would not move away from state 6 to state 7, state 6 is default stable for him. Consequently, there is no need to assess state 6 for stability under the other solution concepts. Likewise, states 13, 20, and 27 are also

default stable for President Obama. This is because states 14, 21, and 28 are not perceived by President Obama and, thus, he would not move away from states 13, 20, and 27 to the mentioned three states. Table 4.12 summarizes equilibrium results in President Obama's perceptual graph models.

Table 4.12: Equilibrium Outcomes of President Obama's Perceptual Graph Models

President Obama	Stationary Equilibrium	Transitory Equilibrium	Stationary Pseudo-Equilibrium	Transitory Pseudo-Equilibrium
$(\alpha = 0)$	23, 27	-	-	-
$(\alpha = 1)$		18		9 , 25

Tables 4.13 and 4.14 are perceptual graphs with respect to the Canadian Coalition's viewpoint regarding the Keystone conflict. In Table 4.13, the Canadian Coalition is aware $(\alpha = 1)$ of other DMs' perceptions. However, in Table 4.14, it is not aware $(\alpha = 0)$ of other DMs' inconspicuous states. Columns shown in gray are not perceived by the DM to which the table belongs (e.g., 15, 18, 22, and 25 in Tables 4.13 and 4.14 are hidden in the Canada Coalition's viewpoint).

Apparent Nash stability has not been explored for the owner of the perceptual graph model. In Table 4.13, which belongs to the Canadian Coalition with $\alpha = 1$, state 26 is apparently Nash stable for President Obama. State 26 is an unstable state in his point of view and, thus, he may decide to move away from it to state 25. But since the Canadian Coalition does not perceive state 25 as a recognized state (i.e., it is hidden in its perspective), President Obama cannot move from state 26 to any other state from the Canadian Coalition's viewpoint. Therefore, state 26 is interpreted to be Nash stable for President Obama in the Canadian Coalition's perspective. In this situation, state 26 is defined as an apparently Nash stable state for President Obama.

As perceived by the Canadian Coalition in Table 4.13, states 5, 12, 19, and 26 are GMR and SEQ SAUN. The Canadian Coalition can improve from the mentioned states to states 7, 14, 21, and 28. However, in Table 4.13, these target states are not perceived by President Obama and the Canadian Coalition is aware of this issue. Therefore, the Canadian Coalition has the advantage of not being worried about sanctions by the US.

According to the graph form in Figure 4.3, President Obama can move from state 6 to state 7. However, since in Table 4.13, the Canadian Coalition is aware that President Obama does not perceive state 7, state 6 becomes apparently default stable for him in the Canadian Coalition's perceptual graph.

Table 4.13: Stability Analysis Based on Perceptual Graph Model Technique in Canadian Coalition's Point of View (α=1)

Canadian Coalition's viewpoint (α=1)		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
President Obama	Default	N	N	N	N	N	N	/	N	N	N	N	N	N	/		N	N		N	N	/		N	N		N	N	/
	A Default	N	N	N	N	N	Y	/	N	N	N	N	N	Y	/		N	N		Y	Y	/		N	N		Y	Y	/
	Nash	N	Y	N	Y	N	/	/	N	Y	N	Y	N	/	/		Y	N		/	/	/		Y	N		N	/	/
	A Nash	N	N	N	N	N	/	/	N	N	N	N	N	/	/		N	N		/	/	/		N	N		Y	/	/
	GMR	N	Y	N	Y	N	/	/	N	Y	N	Y	N	/	/		Y	N		/	/	/		Y	N		Y	/	/
	SEQ	N	Y	N	Y	N	/	/	N	Y	N	Y	N	/	/		Y	N		/	/	/		Y	N		Y	/	/
	SMR	N	Y	N	Y	N	/	/	N	Y	N	Y	N	/	/		Y	N		/	/	/		Y	N		Y	/	/
Canadian Coalition	Default	N	Y	N	N	N	N	N	N	Y	N	N	N	N	N		Y	N		N	Y	N		Y	N		N	Y	N
	A Default	/	/	/	/	/	/	/	/	/	/	/	/	/	/		/	/		/	/	/		/	/		/	/	/
	Nash	N	/	Y	N	N	Y	N	N	/	Y	N	N	Y	N		/	Y		N	/	N		/	Y		N	/	N
	A Nash	/	/	/	/	/	/	/	/	/	/	/	/	/	/		/	/		/	/	/		/	/		/	/	/
	GMR	N	/	Y	N	SAUN	Y	Y	N	/	Y	N	SAUN	Y	Y		/	Y		SAUN	/	N		/	Y		SAUN	/	Y
	SEQ	N	/	Y	N	SAUN	Y	N	N	/	Y	N	SAUN	Y	N		/	Y		SAUN	/	N		/	Y		SAUN	/	N
	SMR	N	/	Y	N	N	Y	Y	N	/	Y	N	N	Y	Y		/	Y		N	/	N		/	Y		N	/	Y
Republicans	Default	N	N	N	N	N	N	N	N	N	N	N	N	N	N		N	N		N	N	N		N	N		N	N	N
	A Default	N	N	N	N	N	N	N	N	N	N	N	N	N	N		N	N		N	N	N		N	N		N	N	N
	Nash	N	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y		N	N		N	N	N		Y	Y		Y	Y	Y
	A Nash	N	N	N	N	N	N	N	N	N	N	N	N	N	N		N	N		N	N	N		N	N		N	N	N
	GMR	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y		Y	Y		Y	Y	N		Y	Y		Y	Y	Y
	SEQ	Y	N	N	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y		N	N		Y	N	N		Y	Y		Y	Y	Y
	SMR	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y		Y	Y		Y	Y	N		Y	Y		Y	Y	Y
NDEQ	Default	N	/	N	N	N	N	N	N	/	N	N	N	N	N		N	N		N	N	N		N	N		N	N	N
	A Default	Y	/	N	Y	N	N	N	Y	/	N	Y	N	N	N		Y	N		N	N	N		Y	N		N	N	N
	Nash	/	/	N	/	N	N	N	/	/	N	/	N	N	N		/	Y		Y	Y	Y		/	Y		Y	Y	Y
	A Nash	/	/	N	/	N	N	N	/	/	N	/	N	N	N		/	N		N	N	N		/	N		N	N	N
	GMR	/	/	Y	/	Y	Y	Y	/	/	Y	/	Y	Y	Y		/	Y		Y	Y	Y		/	Y		Y	Y	Y
	SEQ	/	/	Y	/	Y	N	Y	/	/	Y	/	Y	N	Y		/	Y		Y	Y	Y		/	Y		Y	Y	Y
	SMR	/	/	Y	/	Y	Y	Y	/	/	Y	/	Y	Y	Y		/	Y		Y	Y	Y		/	Y		Y	Y	Y

Table 4.14: Stability Analysis Based on Perceptual Graph Model Technique in Canadian Coalition's Point of View (α = 0)

Canadian Coalition's viewpoint (α=0)		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
President Obama	Default	N	N	N	N	N	N	N	N	N	N	N	N	N	N		N	N		Y	N	N		N	N		Y	N	N
	Nash	N	Y	N	Y	N	Y	N	N	Y	N	Y	N	Y	N		Y	N		/	Y	N		Y	N		/	Y	N
	GMR	N	Y	Y	Y	N	Y	N	N	Y	N	Y	N	Y	N		Y	N		/	Y	N		Y	N		/	Y	N
	SEQ	N	Y	Y	Y	N	Y	N	N	Y	N	Y	N	Y	N		Y	N		/	Y	N		Y	N		/	Y	N
	SMR	N	Y	Y	Y	N	Y	N	N	Y	N	Y	N	Y	N		Y	N		/	Y	N		Y	N		/	Y	N
Canadian Coalition	Default	N	Y	N	N	N	N	N	N	Y	N	N	N	N	N		Y	N		N	Y	N		Y	N		N	Y	N
	Nash	N	/	Y	N	N	Y	N	N	/	Y	N	N	Y	N		/	Y		N	/	N		/	Y		N	/	N
	GMR	N	/	Y	N	Y	Y	Y	N	/	Y	N	Y	Y	Y		/	Y		Y	/	Y		/	Y		Y	/	Y
	SEQ	N	/	Y	N	N	Y	N	N	/	Y	N	N	Y	N		/	Y		N	/	N		/	Y		N	/	N
	SMR	N	/	Y	N	Y	Y	Y	N	/	Y	N	Y	Y	Y		/	Y		Y	/	Y		/	Y		Y	/	Y
Republicans	Default	N	N	N	N	N	N	N	N	N	N	N	N	N	N		N	N		N	N	N		N	N		N	N	N
	Nash	N	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y		N	N		N	N	N		Y	Y		Y	Y	Y
	GMR	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y		Y	Y		Y	Y	N		Y	Y		Y	Y	Y
	SEQ	Y	N	N	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y		N	N		Y	N	N		Y	Y		Y	Y	Y
	SMR	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y		Y	Y		Y	Y	N		Y	Y		Y	Y	Y
NDEQ	Default	Y	N	N	Y	N	N	N	Y	N	N	Y	N	N	N		N	N		N	N	N		N	N		N	N	N
	Nash	/	N	N	/	N	N	N	/	N	N	/	N	N	N		Y	Y		Y	Y	Y		Y	Y		Y	Y	Y
	GMR	/	N	Y	/	Y	Y	Y	/	N	Y	/	Y	Y	Y		Y	Y		Y	Y	Y		Y	Y		Y	Y	Y
	SEQ	/	N	Y	/	Y	N	Y	/	N	Y	/	Y	N	Y		Y	Y		Y	Y	Y		Y	Y		Y	Y	Y
	SMR	/	N	Y	/	Y	Y	Y	/	N	Y	/	Y	Y	Y		Y	Y		Y	Y	Y		Y	Y		Y	Y	Y

Table 4.15: Equilibrium Outcomes of Canadian Coalition's Graph Models

Canadian Coalition	Stationary Equilibrium	Transitory Equilibrium	Stationary Pseudo-Equilibrium	Transitory Pseudo-Equilibrium
$(\alpha = 0)$	23 , 27	-	-	-
$(\alpha = 1)$		-		9

State 9 is privately stable for the Canadian Coalition according to Table 4.13. However, since NDEQ does not perceive state 9, this state is a transitory pseudo-equilibrium in the Canadian Coalition's point of view. Although project approval is a favorable situation for the Canadian Coalition, NDEQ being silent is less likely to occur. In the real world, state 9 could only be an intermediary state for NDEQ, meaning that it may make a unilateral improvement to state 23. Table 4.15 summarizes the equilibria results of Tables 4.13 and 4.14.

Republicans' perceptual graphs are summarized in Tables 4.16 and 4.17. In the former table, Republicans are aware of the other DMs' perceived and not perceived states, while in the latter, they have not perceived other DMs' hidden states. According to the study's assumption, Republicans are the only DMs that have perceived all the feasible states.

Table 4.16: Stability Analysis Based on Perceptual Graph Model Technique in Republican's Point of View (α=1)

Republicans viewpoint (α=1)		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
President Obama	Default	N	N	N	N	N	N	/	N	N	N	N	N	N	/	N	N	N	N	N	N	/	N	N	N	N	N	N	/
	A Default	N	N	N	N	N	Y	/	N	N	N	N	N	Y	/	N	N	N	N	N	Y	/	N	N	N	N	N	Y	/
	Nash	N	Y	N	Y	N	/	/	N	Y	N	Y	N	/	/	N	Y	N	Y	N	/	/	N	Y	N	Y	N	/	/
	A Nash	N	N	N	N	N	/	/	N	N	Y	N	N	/	/	N	N	N	N	N	/	/	N	N	N	N	N	/	/
	GMR	N	Y	Y	Y	N	/	/	N	Y	N	Y	N	/	/	N	Y	N	Y	N	/	/	N	Y	N	Y	N	/	/
	SEQ	N	Y	Y	Y	N	/	/	N	Y	N	Y	N	/	/	N	Y	N	Y	N	/	/	N	Y	N	Y	N	/	/
	SMR	N	Y	Y	Y	N	/	/	N	Y	N	Y	N	/	/	N	Y	N	Y	N	/	/	N	Y	N	Y	N	/	/
Canadian Coalition	Default	N	Y	N	N	N	N	N	N	Y	N	N	N	N	N	/	Y	N	/	N	N	N	/	Y	N	/	N	N	N
	A Default	N	/	N	N	N	N	N	N	/	N	N	N	N	N	/	/	N	/	N	Y	N	/	/	N	/	N	Y	N
	Nash	N	/	Y	N	N	Y	N	N	/	Y	N	N	Y	N	/	/	Y	/	N	/	N	/	/	Y	/	N	/	N
	A Nash	N	/	N	N	N	N	N	N	/	N	N	N	N	N	/	/	N	/	N	/	N	/	/	N	/	N	/	N
	GMR	Y	/	Y	N	Y	Y	Y	N	/	Y	N	Y	Y	Y	/	/	Y	/	Y	/	Y	/	/	Y	/	N	/	Y
	SEQ	Y	/	Y	N	N	Y	N	N	/	Y	N	N	Y	N	/	/	Y	/	N	/	N	/	/	Y	/	N	/	N
	SMR	Y	/	Y	N	Y	Y	Y	N	/	Y	N	Y	Y	Y	/	/	Y	/	Y	/	Y	/	/	Y	/	N	/	Y
Republicans	Default	N	N	N	N	N	N	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Y	N	N	N
	A Default	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
	Nash	N	N	N	N	N	N	N	Y	/	Y	Y	Y	Y	Y	N	N	N	N	N	N	N	Y	Y	Y	/	Y	Y	Y
	A Nash	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
	GMR	Y	Y	Y	Y	Y	Y	N	Y	/	Y	Y	Y	Y	Y	Y	Y	Y	SAUN	Y	Y	N	Y	Y	Y	/	Y	Y	Y
	SEQ	Y	N	N	Y	Y	N	N	Y	/	Y	Y	Y	Y	Y	Y	N	N	SAUN	Y	N	N	Y	Y	Y	/	Y	Y	Y
	SMR	Y	Y	Y	Y	Y	Y	N	Y	/	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	N	Y	Y	Y	/	Y	Y	Y
NDEQ	Default	N	/	N	N	N	N	N	N	/	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
	A Default	N	/	N	N	N	N	N	N	/	N	N	N	N	N	N	Y	N	N	N	N	N	N	Y	N	N	N	N	N
	Nash	N	/	N	N	N	N	N	N	/	N	N	N	N	N	Y	/	Y	Y	Y	Y	Y	Y	/	Y	Y	Y	Y	Y
	A Nash	N	/	N	N	N	N	N	N	/	N	N	N	N	N	N	/	N	N	N	N	N	N	/	N	N	N	N	N
	GMR	Y	/	Y	Y	Y	Y	Y	Y	/	Y	Y	Y	Y	Y	Y	/	Y	Y	Y	Y	Y	Y	/	Y	Y	Y	Y	Y
	SEQ	Y	/	Y	N	N	N	Y	Y	/	Y	Y	Y	N	Y	Y	/	Y	Y	Y	Y	Y	Y	/	Y	Y	Y	Y	Y
	SMR	Y	/	Y	Y	Y	Y	Y	Y	/	Y	Y	Y	Y	Y	Y	/	Y	Y	Y	Y	Y	Y	/	Y	Y	Y	Y	Y

Table 4.17: Stability Analysis Based on Perceptual Graph Model Technique in Republicans' Point of View (α=0)

Republicans viewpoint (α=0)		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
President Obama	Default	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
	Nash	N	Y	N	Y	N	Y	N	N	Y	N	Y	N	Y	N	N	Y	N	Y	N	Y	N	N	Y	N	Y	N	Y	N
	GMR	N	Y	Y	Y	N	Y	N	N	Y	N	Y	N	Y	N	N	Y	N	Y	N	Y	N	N	Y	N	Y	N	Y	N
	SEQ	N	Y	Y	Y	N	Y	N	N	Y	N	Y	N	Y	N	N	Y	N	Y	N	Y	N	N	Y	N	Y	N	Y	N
	SMR	N	Y	Y	Y	N	Y	N	N	Y	N	Y	N	Y	N	N	Y	N	Y	N	Y	N	N	Y	N	Y	N	Y	N
Canadian Coalition	Default	N	Y	N	N	N	N	N	N	Y	N	N	N	N	N	N	Y	N	N	N	N	N	N	Y	N	N	N	N	N
	Nash	N	/	Y	N	N	Y	N	N	/	Y	N	N	Y	N	N	/	Y	N	N	Y	N	N	/	Y	N	N	Y	N
	GMR	N	/	Y	N	Y	Y	Y	N	/	Y	N	Y	Y	Y	N	/	Y	N	Y	Y	Y	N	/	Y	N	N	Y	Y
	SEQ	N	/	Y	N	N	Y	N	N	/	Y	N	N	Y	N	N	/	Y	N	N	Y	N	N	/	Y	N	N	Y	N
	SMR	N	/	Y	N	Y	Y	Y	N	/	Y	N	Y	Y	Y	N	/	Y	N	Y	Y	Y	N	/	Y	N	N	Y	Y
Republicans	Default	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
	Nash	N	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y
	GMR	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y
	SEQ	Y	N	N	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y
	SMR	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y
NDEQ	Default	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
	Nash	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	GMR	Y	N	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	SEQ	Y	N	Y	N	N	N	Y	Y	N	Y	N	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	SMR	Y	N	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Table 4.18: Equilibrium Outcomes of Republicans' Graph Models

Republicans	Stationary Equilibrium	Transitory Equilibrium	Stationary Pseudo-Equilibrium	Transitory Pseudo-Equilibrium
$(\alpha = 0)$	23 , 27	-	-	-
$(\alpha = 1)$		-		9 , 25

As indicated in Table 4.18, states 23 and 27 are overall equilibria under all variants of awareness for Republicans. State 9 is Republicans' favorite situation. State 9 reflects the situation where President Obama approves the project under Republicans' pressure with no objection from NDEQ. Although this state satisfies all solution concepts in Republicans' perceptual graph, it is hidden in NDEQ's point of view and, thus, is a transitory pseudo-equilibrium.

As shown in Tables 4.19 and 4.20, which are NDEQ perceptual graphs, states 23 and 27 are overall equilibria in NDEQ's point of view because they satisfy all the main solution concepts. In the former table, NDEQ is aware of the other DMs' perceptions regarding the Keystone XL conflict, while in the latter it has not perceived other DMs' hidden states. States 2 and 9 are shown in gray columns and are not perceived (i.e., are hidden) by NDEQ.

In Table 4.19, state 10 is stable under particular solution concepts (GMR, SMR, and SEQ, but not Nash) in the view of NDEQ and President Obama. Since NDEQ is aware that states 15 and 22 are not perceived by the Canadian Coalition, NDEQ can have UIs from states 1 and 8 to states 15 and 22. Thus, states 1 and 8 are SAUN under GMR and SMR solution concepts.

Table 4.19: Stability Analysis Based on Perceptual Graph Model Technique in NDEQ's Point of View (α=1)

NDEQ'S viewpoint (α=1)		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
President Obama	Default	N		N	N	N	N	/	N		N	N	N	N	/	N	N	N	N	N	N	/	N	N	N	N	N	N	/
	A Default	N		N	N	N	Y	/	N		N	N	N	Y	/	N	N	N	N	N	Y	/	N	N	N	N	N	Y	/
	Nash	N		N	Y	N	/	/	N		N	Y	N	/	/	N	Y	N	Y	N	/	/	N	Y	N	Y	N	/	/
	A Nash	N		N	N	N	/	/	N		N	N	N	/	/	N	N	N	N	N	/	/	N	N	N	N	N	/	/
	GMR	N		Y	Y	N	/	/	Y		Y	Y	N	/	/	N	Y	N	Y	N	/	/	N	Y	N	Y	N	/	/
	SEQ	N		Y	Y	N	/	/	Y		Y	Y	N	/	/	N	Y	N	Y	N	/	/	N	Y	N	Y	N	/	/
	SMR	N		Y	Y	N	/	/	Y		Y	Y	N	/	/	N	Y	N	Y	N	/	/	N	Y	N	Y	N	/	/
Canadian Coalition	Default	N		N	N	N	N	N	N		N	N	N	N	N	/	Y	N	/	N	N	N	/	Y	N	/	N	N	N
	A Default	N		N	N	N	N	N	N		N	N	N	N	N	/	/	N	/	N	Y	N	/	/	N	/	N	Y	N
	Nash	N		Y	N	N	Y	N	N		Y	N	N	Y	N	/	/	Y	/	N	/	N	/	/	Y	/	N	/	N
	A Nash	N		N	N	N	N	N	N		N	N	N	N	N	/	/	N	/	N	/	N	/	/	N	/	N	/	N
	GMR	N		Y	N	Y	Y	Y	N		Y	N	Y	Y	Y	/	/	Y	/	Y	/	Y	/	/	Y	/	N	/	Y
	SEQ	N		Y	N	N	Y	N	N		Y	N	N	Y	N	/	/	Y	/	N	/	N	/	/	N	/	N	/	N
	SMR	N		Y	N	Y	Y	Y	N		Y	N	Y	Y	Y	/	/	Y	/	Y	/	Y	/	/	Y	/	N	/	Y
Republicans	Default	N		N	N	N	N	N	N		N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
	A Default	N		N	N	N	N	N	N		N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
	Nash	N		N	N	N	N	N	Y		Y	Y	Y	Y	Y	N	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y
	A Nash	N		N	N	N	N	N	N		N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
	GMR	Y		Y	Y	Y	Y	N	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y
	SEQ	Y		N	Y	Y	N	N	Y		Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y
	SMR	Y		Y	Y	Y	Y	N	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y
NDEQ	Default	N		N	N	N	N	N	N		N	N	N	N	N	N	Y	N	N	N	N	N	N	Y	N	N	N	N	N
	A Default	/		/	/	/	/	/	/		/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
	Nash	N		N	N	N	N	N	N		N	N	N	N	N	Y	/	Y	Y	Y	Y	Y	Y	/	Y	Y	Y	Y	Y
	A Nash	/		/	/	/	/	/	/		/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
	GMR	SAUN		y	Y	Y	Y	Y	SAUN		Y	Y	Y	Y	Y	Y	/	Y	Y	Y	Y	Y	Y	/	Y	Y	Y	Y	Y
	SEQ	SAUN		Y	N	N	N	Y	SAUN		Y	N	Y	N	Y	Y	/	Y	Y	Y	Y	Y	Y	/	Y	Y	Y	Y	Y
	SMR	N		Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	/	Y	Y	Y	Y	Y	Y	/	Y	Y	Y	Y	Y

Table 4.20: Stability Analysis Based on Perceptual Graph Model Technique in NDEQ's Point of View (α=0)

NDEQ'S viewpoint (α=0)		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
President Obama	Default	N		N	N	N	N	N	N		N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
	Nash	N		Y	Y	N	Y	N	N		Y	Y	N	Y	N	N	Y	N	Y	N	Y	N	N	Y	N	Y	N	y	N
	GMR	N		Y	Y	N	Y	N	Y		Y	Y	N	Y	N	N	Y	N	Y	N	Y	N	N	Y	N	Y	N	Y	N
	SEQ	N		Y	Y	N	Y	N	Y		Y	Y	N	Y	N	N	Y	N	Y	N	Y	N	N	Y	N	Y	N	Y	N
	SMR	N		Y	Y	N	Y	N	Y		Y	Y	N	Y	N	N	Y	N	Y	N	Y	N	N	Y	N	Y	N	Y	N
Canadian Coalition	Default	N		N	N	N	N	N	N		Y	N	N	N	N	N	Y	N	N	N	N	N	N	Y	N	N	N	N	N
	Nash	N		Y	N	N	Y	N	N		Y	N	N	Y	N	N	/	Y	N	N	Y	N	N	/	Y	N	N	Y	N
	GMR	N		Y	N	Y	Y	Y	N		Y	N	Y	Y	Y	N	/	Y	N	Y	Y	Y	N	/	Y	N	N	Y	Y
	SEQ	N		Y	N	N	Y	N	N		Y	N	N	Y	N	N	/	Y	N	N	Y	N	N	/	Y	N	N	Y	N
	SMR	N		Y	N	Y	Y	Y	N		Y	N	Y	Y	Y	N	/	Y	N	Y	Y	Y	N	/	Y	N	N	Y	Y
Republicans	Default	N		N	N	N	N	N	N		N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
	Nash	N		N	N	N	N	N	Y		Y	Y	Y	Y	Y	N	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y
	GMR	Y		Y	Y	Y	Y	N	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y
	SEQ	Y		N	Y	Y	N	N	Y		Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y
	SMR	Y		Y	Y	Y	Y	N	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y
NDEQ	Default	N		N	N	N	N	N	N		N	N	N	N	N	N	Y	N	N	N	N	N	N	Y	N	N	N	N	N
	Nash	N		N	N	N	N	N	N		N	N	N	N	N	Y	/	Y	Y	Y	Y	Y	Y	/	Y	Y	Y	Y	Y
	GMR	Y		Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	/	Y	Y	Y	Y	Y	Y	/	Y	Y	Y	Y	Y
	SEQ	Y		Y	N	N	N	Y	Y		Y	N	Y	N	Y	Y	/	Y	Y	Y	Y	Y	Y	/	Y	Y	Y	Y	Y
	SMR	Y		Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	/	Y	Y	Y	Y	Y	Y	/	Y	Y	Y	Y	Y

As shown in Table 4.21, states 10 and 18 satisfy all solution concepts except Nash equilibrium. State 10 is a transitory equilibrium under all variants of NDEQ awareness, while state 18 is only a transitory equilibrium when NDEQ is aware of other DMs' hidden states.

Table 4.21: Equilibrium Outcomes of NDEQ's Graph Models

NDEQ	Stationary Equilibrium	Transitory Equilibrium	Stationary Pseudo-Equilibrium	Transitory Pseudo-Equilibrium
$(\alpha = 0)$	23 , 27	10	-	-
$(\alpha = 1)$		10 , 18		25

4.9. Overall Equilibrium Resulting from Meta-Stability Analysis

According to Table 4.22, states 23 and 27 are stationary equilibria for all the DMs since they satisfy all solution concepts in all DMs' perceptual graphs in all variants of awareness. The mentioned states were also overall stable in the standard graph model summarized in Table 4.5. State 27 represents a situation in which President Obama rejects the project under pressure from the NDEQ. In this situation, the Canadian Coalition diversifies its oil sands bitumen to Asia and no longer tries to convince its important customer, the US. This leads to extreme pressure from Republicans who agree with construction of the Keystone XL pipeline because of its economic benefits.

On the other hand, since the DOS indicated in its latest EIS report that the project satisfies US national interests, it seems that President Obama would eventually approve the project, as indicated in state 23. However, the approval could be conditional. Both Canada and the US could agree on some modifications to mitigate the environmental impacts of proceeding with the

project. However, these modifications would not be so major that TransCanada would need to reapply for a presidential permit.

State 10 satisfied all solution concepts except Nash stability in all DMs' viewpoints in some variants of awareness. Therefore, it is a transitory equilibrium state for all the DMs. Although state 18 is a transitory equilibrium in President Obama's and NDEQ's graph models, this state is not perceived (i.e., is hidden) by the Canadian Coalition. Therefore, in Table 4.22, only state 10 is regarded as an overall transitory equilibrium state.

State 10 expresses the situation where President Obama requests major modifications from the Canadian Coalition. Since NDEQ prefers that the project be either canceled by the Canadian Coalition or rejected by President Obama, a modification request is a relatively preferred condition in NDEQ's point of view. State 10 has the potential to provide a peaceful resolution if the Canadian Coalition decides to modify the project to maintain the US as its main customer.

Table 4.22: Summary of Meta-Stability Analysis of the Keystone XL Pipeline

	In some but not all variants of awareness	**In all variants of awareness**
Perceived by all DMs	Transitory equilibrium Nash: none GMR,SMR,SEQ: 10	Stationary equilibrium Nash: 23, 27 GMR,SMR,SEQ: 23, 27
Perceived by some but not all DMs	Transitory pseudo-equilibrium Nash:9,25 GMR,SMR,SEQ: 9,25	Stationary pseudo-equilibrium Nash: none GMR,SMR,SEQ: none

State 9 is not perceived by NDEQ, but satisfies all solution concepts for other DMs under some variants of awareness ($\alpha = 1$). Also, the Canadian Coalition does not perceive state 25 while this state is an equilibrium for other DMs when ($\alpha = 1$). Both states 9 and 25 are transitory pseudo-equilibria in at least one DM's point of view. Thus, if they are attained, they might mislead the focal DM in its policy making since these states are not perceived by a DM in the conflict. Moreover, in this case study, the meta-stability analysis did not reveal a state eligible to be considered as a stationary pseudo-equilibrium state.

Chapter Five: Strategic Insights,

Limitations, Conclusions, and Future Studies

5.1. Strategic Insights

Canada is considered a rich country in terms of energy, natural and technological resources. It is necessary to adopt an integrated view with regard to its energy assets. In line with this purpose, a systematic point of view can certainly be beneficial economically and environmentally (Canadian Academy of Engineering Energy Pathways Task Force, 2012a).

The purpose of this systematic analysis here is to carry out a formal study of the Keystone XL pipeline dispute to gain a better understanding and strategic insights. The insights drawn from the study with the assistance of the graph model technique show the credibility of a wide range of capabilities of this technique. Based on a thorough literature review, coupled with the development of conflict models and associated analyses, a range of valuable insights are gained by carrying this type of comprehensive conflict study.

Although the US and Canada are bonded neighboring countries and have the same goal of going forward with the project, many complexities and obstacles have arisen in the process of conducting the project. Even though the two countries have friendly relations, financial strains have affected this relationship to the extent that Canada is opening its energy resources to Asian markets.

The Keystone XL project model further helps the DMs to analyze the strategic conflict and to predict other players' movements and strategies. For example, the analysis reveals that the initial rejection of the project by President Obama could be considered a wise decision. Although the

likelihood of exporting Canada's oil sands bitumen to other markets is high, President Obama knew that the Canadian Coalition is aware of the many environmental impacts of the original Keystone XL pipeline proposal (Gasser, 2012). Consequently, in May of 2012, TransCanada applied again for a Presidential Permit for a rerouted Keystone XL pipeline project. In line with President Obama's preference, Canada did not diversify its oil sands bitumen to Asian markets, even after many statements of its intention to do so. To preserve environmentalist support, President Obama also managed to defer a decision on the project to after the presidential election of 2012. On the other hand, the Republicans were aware of the reasons behind this decision and thus continued pressuring President Obama.

One of the important contributions of applying both standard and perceptual graph model techniques to the Keystone XL project is to understand the dynamic complexity of the multi-participant, multi-objective decision-making process, and the importance of timing. The model not only gives an understanding of the situation at a single point in time, but it can also effectively provide quick support to policy and governance by being revised based on new circumstances to determine the implications. For instance, after Canada's decision to diversify oil sands bitumen to China, rankings of DMs' preferences changed in the proposed model. Requesting modification had been a high priority for the US, but after the initial rejection of the proposal by President Obama, when Canada announced multiple times that it would diversify its oil to regions such as Asia, the risk of possible negative outcomes of modification increased in US's point of view. Thus, US's preference rankings were altered. This change in preferences can be effectively addressed through the graph model technique.

The other insightful conclusion the graph model technique sheds light on is that a short-term perspective towards decision making might not be an ideal strategy for maximum gains. For

example, in the case of sequentially sanctioned states for a particular DM, although a DM makes a transition to a more preferred state in the first move, in the long run, the conflict will end up in a less preferred equilibrium state for that DM. For example, according to Table 3.7 in the case of state 18, although President Obama makes a short-term improvement by transitioning to state 17, because of the unilateral improvements of other DMs, it will see itself in the equilibrium state of 21 after a few transitions. Hence, the graph model technique gives a unique opportunity to DMs to foresee different consequences of their decisions and to take appropriate action towards attaining long-term profits instead of short-term and temporary accomplishments.

As discussed before, DOS is responsible for preparing EIS, which refers to investigating the environmental impacts of the project. DOS should receive comments from the public, states, and tribal and federal agencies. In November of 2011, after evaluating the public's points of view, DOS declared that, to determine the final national decision, it was necessary for the project to be in compliance with various states' regulations along the pipeline route. However, DOS pointed out that the differences in the states' laws, criteria and standards are sources of confusion that add to the complexity of the conflict (Parfomak et al., 2011). Additionally, TransCanada should also pay taxes to different states of the US due to imperfections in the states' laws, criteria and standards. Therefore, this issue could add to the dissatisfaction amongst stakeholders, such as DOS and the Canadian Coalition, further contributing to the complexity of the conflict. By investigating and bringing up these challenges for the DMs, the graph model technique could help policymakers to enhance the current local, national and international laws to support environmental sustainability and to meet social and economic demands from their societies and the stakeholders.

Based on the perceptual graph model technique's results, if the Canadian Coalition gets serious about exporting oil sands bitumen to Asia, President Obama would have to deal with a sensitive situation. Rejection or even requesting major modifications regarding the Keystone XL project may lead to dismissal of the project by the Canadian Coalition. The Canadian Coalition would likely even diversify its oil sands bitumen to the US's rival countries.

Although environmentalists would be appeased by President Obama's decision, this rejection could affect two bonded neighboring countries' relations in different fields, such as economics and politics. Moreover, Republicans would not be satisfied since in their view thousands of job opportunities would be lost and worse, dependence on the Middle East for imported energy would increase. On the other hand, if President Obama approves the project, not only would environmentalists object, but the US would be under increasing pressure from other countries to reconsider the pipeline's negative environmental impacts on the globe. Therefore, it is critical for President Obama to be aware of other DMs' preferences to make a wise decision.

As revealed by meta-stability analysis, states 23 and 27 are the most robust states in the proposed model. However, state 10 is also a nominee as a resolution for the Keystone XL conflict. The Canadian Coalition seems to be keen to remove the negative environmental impacts of the project. This concern could exist partly because diminishing the negative environmental effects would increase Canada's credibility as an environment-friendly nation in the eyes of the world. Therefore, by pointing out the mentioned issue, President Obama could try to convince the Canadian Coalition to reconsider the current Keystone XL proposal.

The greater the number of DMs, the smaller the probability of finding a robust solution that meets all DMs' preferences. However, when the DMs are aware of each other's preferences and

hidden states, they can make wiser decisions in solving the conflict. Being aware of other DMs' recognized states can increase the possibility of successful negotiations between the DMs.

5.2. Limitations

As discussed previously, identifying and sorting the feasible states in a proposed model is a subjective procedure based on the opinions and judgments of the researcher. Thus, it is important to find ways to decrease the bias associated with this subjectivity in standard and perceptual graph model techniques.

The perceptual graph model technique used in this study assumed two kinds of awareness for each DM. They were either aware of all other DMs' hidden states or they were not. The combination of these two assumptions was not studied. For example, in one real-world scenario, President Obama as the focal DM can be aware of all other DMs' hidden states. In another situation, he can be aware of only the Canadian Coalition's hidden and recognized states. In a different scenario, he could be aware of the Canadian Coalition's and NDEQ's hidden states. Each of these scenarios would lead to different stability analysis results. Although this process could be time-consuming, it would ensure more accurate concluding remarks and analyses regarding the conflict.

5.3. Conclusions

Exporting bitumen from the oil sands in Canada through the Keystone XL pipeline is a controversial topic between Canada and the US. A strategic investigation to identify key factors – DMs, their options and preferences, feasible states, and transitions to more preferred states – is conducted to structure the model. Considering the different aspects of this conflict categorized

into environmental-social-health, political, and economic dimensions, this crucial real-world issue is systematically studied.

The projected economic benefits of the Keystone XL conflict are in contradiction with the environmental preservation that the world currently needs. Using the graph model technique, the current study aims to provide a wise balance between these two sides. Therefore, in addition to facilitating communication and cooperation among DMs, the quality of understanding, negotiation and mediation among them would be enhanced. This enables a variety of groups, most importantly managers, to better understand and make decisions regarding operation and leadership of their organizations towards higher efficiency and productivity. In turn, with this systematic approach, environmental issues can also be addressed through undertaking a more sustainable approach.

Moreover, most of the main and influential DMs of the studied conflict are local or governmental organizations. Also, some of the DMs consist of two or more organizations working together to make decisions. Therefore, this research can be useful in understanding the dynamics of the multi-participant decision-making process and how each party plays a role in the final decision.

5.4. Future Studies

Subjective analysis is used in some steps of the development of standard and perceptual graph models. This includes, but is not limited to, developing structured guidelines for gathering background information, determining main and influential DMs' wants and needs, and ranking state preferences., Future research should focus on both standard and perceptual graph model

techniques' processes and solution concepts' definitions to obtain simpler, yet more objective definitions and procedures.

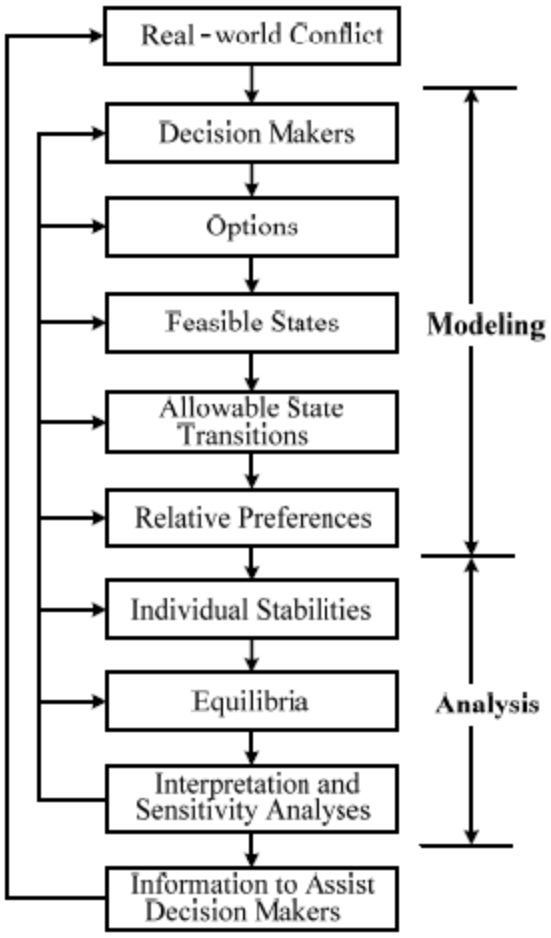
By means of increasing the objectiveness of standard and perceptual graph model techniques, it is recommended that the Keystone XL pipeline dispute be explored by other authors as well. Comparing the conclusions of all the studies on this specific conflict would enhance our understanding of the effects each author's perception has on modeling and analyzing the conflict.

As indicated in the thesis, this controversial conflict is still an ongoing dispute. After President Obama's decision on either approving or rejecting the Keystone XL pipeline project has been announced, a comparison between real world occurrences and the current study's results needs to be conducted. This should provide an insight into standard and perceptual graph model techniques and would assist future researchers in modeling and analyzing other conflicts using these techniques.

Appendices

Appendix A: Standard Graph Model

Figure A1. Implementation of Graph Model for Conflict Resolution



Formal Definitions Regarding the Standard Graph Model for Conflict Resolution

Definition 1. The Graph Model for Conflict Resolution

The set of all DMs is *N*, where $|N| \geq 2$.

The set of all states in the conflict is *S*, (S,A_i), where $2 \leq |S| \leq N$.

For each DM $i \in N$, $A_i \subset S \times S$ is the set of state transitions or set of all arcs controlled by *i*.

(s_1 , s_2) is an arc in DM *i*'s directed graph, if DM *i* can reach, in a one-step transition, state s_2 from state s_1.

DM *i*'s preference on S is shown by a pair of binary relationships $\{\succ_i , \sim_i\}$ on *S*; where $s_2 \succ_i s_1$ means DM *i* prefers s_2 to s_1, and $s_2 \sim_i s_1$ means DM *i* equally prefers s_2 and s_1. The relationship $s_2 \succcurlyeq_i s_1$ means that DM *i* prefers state s_2 to s_1 or equally prefers s_1 and s_2.

In a standard graph model, based on DM *i*'s elicited preferences over states, *S* can be partitioned into two sets, relative to a particular state $s \in S$ (i.e., *s* is being assessed for stability), as follows: $\Phi_i^+(s) = \{s_m \in S : s_m \succ_i s\}$ is the set of all states that DM *i* prefers to state *s*; and $\Phi_i^{\leq}(s) = \{s_m \in S : s \succcurlyeq_i s_m\}$ is the set of all states that DM *i* finds equally or less preferred to state *s*. *Finally G*= $[N,S,(A_i)_{i\epsilon N},(\succcurlyeq_i)_{i\epsilon N})]$, and is called a *standard graph model*.

(1) $\succ_i$ is asymmetric; hence, for all $s_1, s_2 \in$ S, $s_1 \succ_i s_2$and $s_2 \succ_i s_1$ cannot hold simultaneously.

(2) $\sim_i$ is reflexive; thus, for any $s_1 \in$ S, $s_1 \sim_i s_1$.

(3) $\sim_i$ is symmetric; i.e, for all $s_1, s_2 \in$ S, if $s_1 \sim_i s_2$ then $s_2 \sim_i s_1$.

(4) $\{\succ_i, \sim_i\}$ is complete; thus, for all $s_1, s_2 \in$ S, exactly one of $s_1 \succ_i s_2$, $s_2 \succ_i s_1$ or $s_1 \sim_i s_2$ is true.

Definition 2. Reachable List

For $i \in N$, and $s \in S$ DM *i's reachable list from state s is the set* $\{s_2 \in S | (s_1, s_2) \in A_i\}$ denoted by $R_i(s) \subset S$. When individual DMs unilaterally cause transitions among states from an initial state, or *status quo*, to a final state that is stable for all DMs.

Definition 3. Unilateral Improvement (UI) List for each DM

In the Graph Model, the set of all states that DM *i* can unilaterally reach from state $s \in S$ in one step is the reachable list $R_i(s)$. A UI from a particular state for a specific DM is a preferred state for that DM to which he or she can unilaterally move in one step. $R_i(s)$'s two subsets are: $R_i^+(s) = R_i(s) \cap \Phi_i^+(s)$ is the set of all UIs from state *s* for DM *i*; and $R_i(s) = R_i(s) \cap \Phi_i^{\lesssim}(s)$ is the set of all unilateral disimprovements and equally preferred states from state *s* for DM *i*.

Definition 4. Nash Stability (Rationality)

For $i \in N$, a state $s \in S$ is Nash stable for DM *i*, denoted by $s \in S^{Nash_i}$, iff $R_i^+(s) = \emptyset$. Under the Nash solution concept, a DM will move to a more preferred state whenever possible, without regard to any possible countermoves by the opponent.

Definition 5. General Metarationality (GMR)

For $i \in N$, a state $s \in S$ is general metarational stable for DM *i*, denoted by $s \in S^{GMR_i}$, iff for every $t \in R_i^+(s)$ there exists $R_j(t) \cap \Phi_i^{\lesssim}(s) \neq \emptyset$. Thus, a state *s* is general metarational stable for DM *i* iff for every UI *i* can take advantage of, the opponent, DM *j*, can subsequently move to a state that is at most as good for *i* as the original state *s*.

Definition 6. Symmetric Metarationality (SMR)

For $i \in N$, a state $s \in S$ is symmetric metarational stable for DM *i*, denoted by $s \in S^{SMR_i}$, iff for every $t \in R_i^+(s)$, $R_j(t) \cap \Phi_i^{\lesssim}(s) \neq \emptyset$, and for all $h \in R_j(t) \cap \Phi_i^{\lesssim}(s)$, $R_i(h) \cap \Phi_i^+(s) = \emptyset$. A state *s* is symmetric metarational stable for DM *i* iff not only every UI for *i* from *s* is sanctioned by the

opponent, but no unilateral counterresponse by DM *i* can leave it better off than the original state *s*.

Definition 7. Sequential Stability (SEQ)

For $i \in N$, a state $s \in S$ is sequentially stable for DM *i*, denoted by $s \in S^{SEQ_i}$, iff for every $t \in R_i^+(s)$ there exists $R_j^+(t) \cap \Phi_i^{\leq}(s) \neq \emptyset$. A state *s* is sequentially stable for DM *i* iff every UI for *i* from *s*, state *s* is *credibly sanctioned* by the sanctioner DM *j*.

Figure A2. Sample Individual Stability Using GMCRII Support System for Original Model in Chapter 3

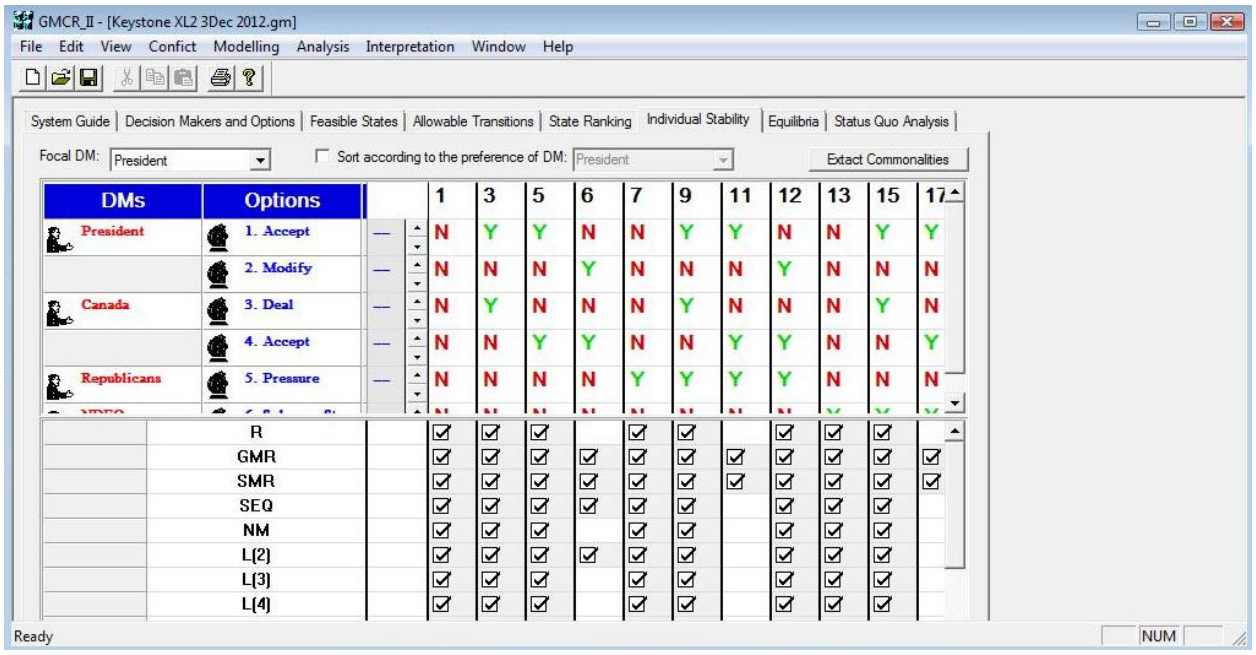


Figure A3.Sample Overall Stability Using GMCRII Support System for Original Model in Chapter 3

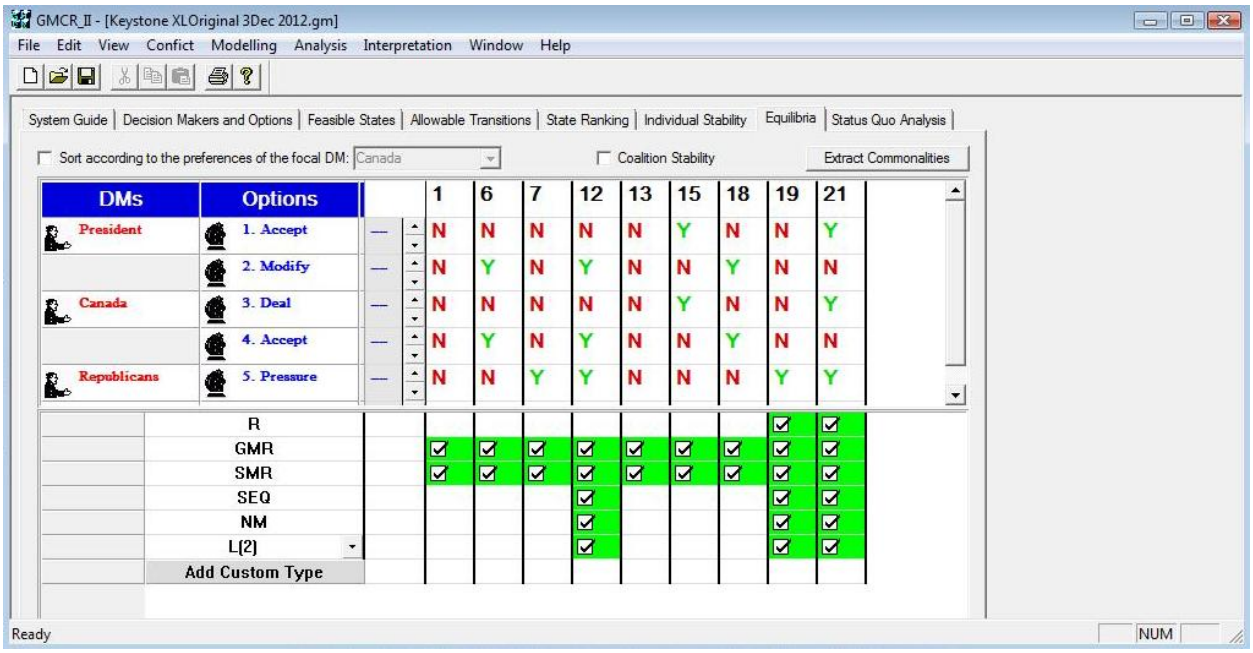
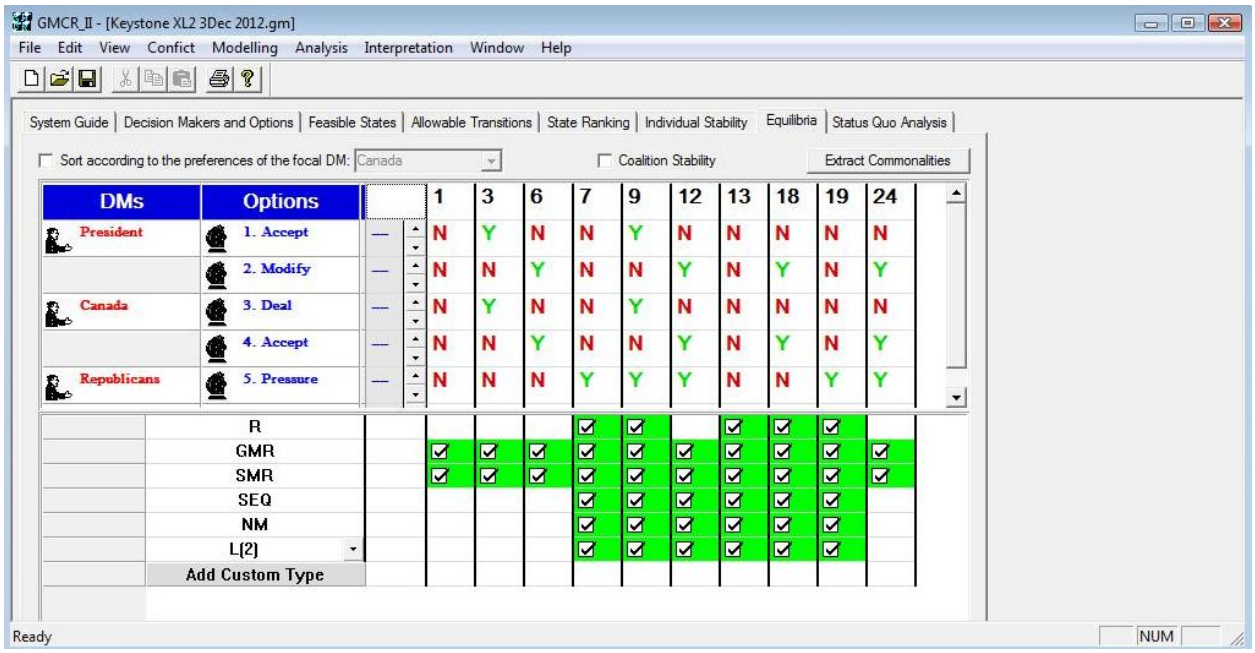


Figure A4. Sample Overall Stability Using GMCRII Support System for Second Scenario in Sensitivity Analysis in Chapter 3



Appendix B: Perceptual Graph Model

Formal Definitions Regarding the Perceptual Graph Model

Definition 1. Recognized States

A perceptual graph model of DM *k* has *k*'s set of *recognized states*. For each DM $k \in N$, let $S_k \subseteq S$ be *k*'s set of recognized states; where S_k is formed by eliminating from *S* all states not visible to *k*. Note that S_k reflects *k*'s perception when some states in *S* are not apparent to all DMs in a model. Naturally, it is assumed that $S_k = S$ if DM *k* recognizes all states in *S*, and $S_k \neq \emptyset$ where Ø is the empty set.

Definition 2. Perceptual Graph Model

DM *k*'s perceptual graph model, is G_k, is based upon S_k; DM *k*'s perception of DM*i*'s state transitions A_i^k that are contained within *Sk*; and DM *k*'s perception of DM *i*'s relative preferences among states $\succcurlyeq_i^k$.

Let α_k be DM *k*'s index of awareness. When $\alpha_k = 0$, then DM *k* is not aware that other DMs perceive different graph models; and when $\alpha_k = 1$, then DM *k* is aware of states in his or her graph that are not perceived by other DMs.

DM *k*'s perceptual graph model is denoted by G_k expressed by $G_k = [N,(S_i^k)_{i\in N}, (A_i^k)_{i\in N}, (\succcurlyeq_i^k)_{i\in N}, \alpha_k]$, and a graph model system consists of a list of all DM's perceptual graph models and is expressed by $\hat{G} = (G1,G2, \ldots, G_k, \ldots, G_n)$, where $i, k \in N$:

S_i^k	DM *k*'s *perception* of *i*'s set of states;
$A_i^k \subset S_k \times S_k$	DM *k*'s *perception* of *i*'s *available* state transitions;
$\succcurlyeq_i^k$	DM *k*'s *perception* of *i*'s relative preference information;
α_k	DM *k*'s index of awareness.

Definition 3. Perceived Default Stability

For $i \in N$ and $k = i$ or $k = j$, a state $s \in S_k \cap S_i$ is perceived by k to be default stable for DM i iff there exists no unilateral move from s for i, i.e., R_i (s) $\cap S_k = \emptyset$.

Definition 4. Apparent Default Stability

For $i \in N$, a state $s \in S^C$ is perceived by j to be an apparently default stable for DM i iff all unilateral moves away from s are inconspicuous to i, i.e., R_i (s) $\cap S^C = \emptyset$ and R_i (s) $\cap S_j^P \neq \emptyset$. It reflects the *limited perception* of a focal DM.

Definition 5. Perceived Nash Stability

For $i \in N$ and $k = i$ or $k = j$, a state $s \in S_k \cap S_i$ is perceived by k to be Nash stable for DM i, denoted by $s \in S_k^{Nash_i}$, iff R_i (s) $\cap S_k \cap S_i \neq \emptyset$ and $R_i^+(s) \cap S_k = \emptyset$. DM k perceives a state to be Nash stable for the focal DM i whenever k believes that there is no preferred state in S_k that i can move to; R_i (s) $\cap S_k \neq \emptyset$ is implied by R_i (s) $\cap S_k \cap S_i \neq \emptyset$, so state s is neither perceived default nor apparently default stable, while the condition $R_i^+(s) \cap S_k = \emptyset$ ensures that there are no UIs for the focal DM i in S_k. Let $S_j^{Nash_i}$ denote the set of states in S_j that are perceived to be *apparently Nash stable* for focal DM i.

Definition 6. Apparent Nash Stability

For $i \in N$, a state $s \in S^C$ is perceived by j to be apparently Nash stable for DM i, denoted by $s \in S_j^{ANash_i}$, iff R_i (s) $\cap S^C \neq \emptyset$ and $R_i^+(s) \cap S^C = \emptyset$, but $R_i^+(s) \cap S_j^P \neq \emptyset$. Apparent Nash stability does not apply to the focal DM who owns the graph model, i.e., $k = i$, since DM i's awareness would be equal to DM k's. Therefore, apparent stability applies only for a focal DM with limited perception.

Definition 7. Perceived GMR Stability

For $i, j \in N$ and $k = i$ or $k = j$, a state $s \in S_k \cap S_i$ is perceived by k to be GMR stable for DM i, denoted by $s \in S_k^{GMR_i}$, iff $R_i^+(s) \cap S^C \neq \emptyset$ and for every $t \in R_i^+(s) \cap S^C$ there exists $R_i(t) \cap \Phi_i^{\leq}(s) \cap S^C \neq \emptyset$. DM k perceives a state to be GMR stable for the focal DM i.

Let $S_k^{GMR_i}$ denote the set of states in S_k that are perceived to be GMR stable for focal DM i.

Definition 8. GMR Strategic Advantage Instability

For $i, j \in N$, a state $s \in S_i$ is perceived by i to be GMR strategic advantage unstable for DM i, denoted by $s \in S_i^{GSAUN_i}$, iff $R_i^+(s) \cap S^C \neq \emptyset$ and there exists $t \in R_i^+(s) \cap S^C$ such that $R_i(t) \cap \Phi_i^{\leq}(s) \cap S^C = \emptyset$ but $R_i(t) \cap \Phi_i^{\leq}(s) \cap S_i^P \neq \emptyset$. Thus, $S_k^{GSAUN_i}$ denotes the set of states in S_i that are perceived to be GMR strategic advantage unstable for focal DM i. Strategic advantage instability reflects the opponent's *limited perception* of the focal DM's UIs or the sanctions to a UI.

Definition 9. GMR Strategic Disadvantage Instability

For $i, j \in N$, a state $s \in S^C$ is perceived by j to be GMR strategic disadvantage unstable for DM i, denoted by $s \in S_j^{GSDUN_i}$,, iff $R_i^+(s) \cap S^C = \emptyset$ and there exists $t \in R_i^+(s) \cap S^C$ such that $R_j(t) \cap \Phi_i^{\leq}(s) \cap S^C = \emptyset$ but $R_j(t) \cap \Phi_i^{\leq}(s) \cap S_j^P \neq \emptyset$. Here, $S_j^{GSDUN_i}$ denotes the set of states in *Sj* that are perceived to be GMR strategic disadvantage unstable for focal DM i.
Strategic disadvantage instability reflects the focal DM's *lack of perception* of the opponent's sanction. Thus, in G_j, DM j has sanctions to some of DM i's UIs that are inconspicuous to DM i.

Definition 10. Perceived SMR Stability

For $i, j \in N$, and $k = i$ or $k = j$, a state $s \in S_k \cap S_i$ is perceived by k to be SMR stable for DM i, denoted by $s \in S_k^{SMR_i}$, iff $R_i^+(s) \cap S^C \neq \emptyset$ and for every $t \in R_i^+(s) \cap S^C$ there exists $R_j(t) \cap \Phi_i^{\leq}(s) \cap S^C \neq \emptyset$, and for all $h \in R_j(t) \cap \Phi_i^{\leq}(s) \cap S^C$ $i(s) \cap S^C$, $R_i(h) \cap \Phi_i^+(s) \cap S_k = \emptyset$. $S_k^{SMR_i}$ denote the set of states in S_k that are perceived to be GMR stable for focal DM i.

Definition 11. Perceived SEQ

For $i, j \in N$, and $k = i$ or $k = j$, a state $s \in S_k \cap S_i$ is perceived by k to be SEQ stable for DM i, denoted by $s \in S_k^{SEQ_i}$, iff $R_i^+(s) \cap S^C \neq \emptyset$ and for every $t \in R_i^+(s) \cap S^C$ there exists $R_j^+(t) \cap \Phi_i^{\leq}(s) \cap S^C \neq \emptyset$. DM k perceives a state to be SEQ stable for the focal DM i when k believes that, if i takes advantage of any possible UI, DM j has a credible sanction [i.e., a state in $R_j^+(t) \cap \Phi_i^{\leq}(s)$]. Therefore $S_k^{SEQ_i}$ denote the set of states in S_k that are perceived to be SEQ stable for focal DM i.

Definition 12.Overall Stability

A state $s \in S_k$ is overall stable for DM $k \in N$ under a particular solution concept iff s is stable for all DMs in k's perceptual graph model. Equilibrium and overall stability are synonyms in a standard graph model as they both refer to a state that is stable for all DMs under a particular solution concept. If $\alpha_k = 1$ then state s is overall stable in G_k if it belongs to the set of commonly perceived states, i.e., $s \in S^C$, and s is stable for both DMs, while if $\alpha_k = 0$, there is no restriction on the location of state s in G_k.

Definition 13. Private Stability

A state $s \in S_k$ is privately stable for DM $k \in N$ under a particular solution concept iff $\alpha k = 1$, $s \in S_k^P$ and s is stable for k under that solution concept.

Definition 14. Equilibrium

A state $s \in S_k$ is an equilibrium under that solution concept iff for every $i \in N$ and $s \in S_i$, s is overall stable for DM i under that solution concept.

For a state to be an equilibrium, it must belong to the set of commonly perceived states S^C and be overall stable in every perceptual graph model.

Definition 15. Pseudo- equilibrium

A state $s \in S_k$ is a pseudo - equilibrium under a particular solution concept iff s is overall stable for every DM i such that $s \in S_k$ for some but not all $i \in N$. The equilibrium (or pseudoequilibrium) of a state under a particular solution concept can be either *stationary* or *transitory*, depending on whether the state is consistently an equilibrium in all, or only some, variants of awareness.

Definition 16. Stationary Equilibrium

A state $s \in S_k$ is a stationary equilibrium under a particular solution concept iff s is an equilibrium in all variants of awareness in a perceptual graph system.

Definition 17. Stationary Pseudo – equilibrium

A state $s \in S_k$that is a pseudo - equilibrium across all variants of awareness is a *stationary pseudo - equilibrium* state, which means that the state is overall stable in some but not all perceptual graph models, independent of the DM's index of awareness, and not recognized by the other DMs.

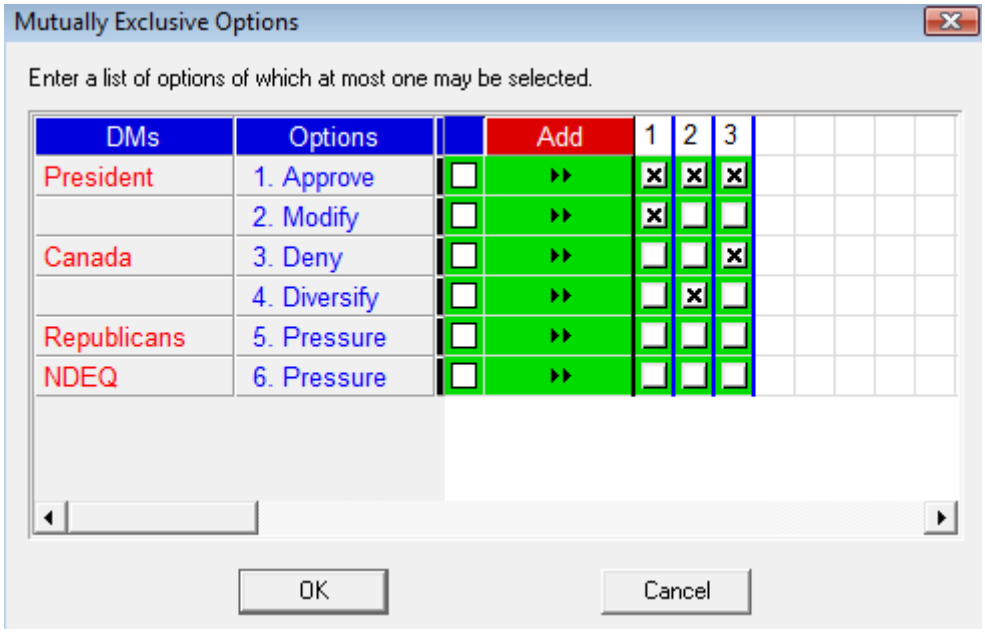
Definition 18. Transitory Equilibrium

A state $s \in S_k$ is a transitory equilibrium under a particular solution concept iff s is an equilibrium in some but not all variants of awareness.

Definition 19.Transitory Pseudo - equilibrium

A state $s \in S_k$ is a transitory pseudo - equilibrium iff s is a pseudo - equilibrium across some but not all variants of awareness.

Figure B1. Infeasible States Elimination Using GMCRII Support System for Constructed Model in Chapter 4



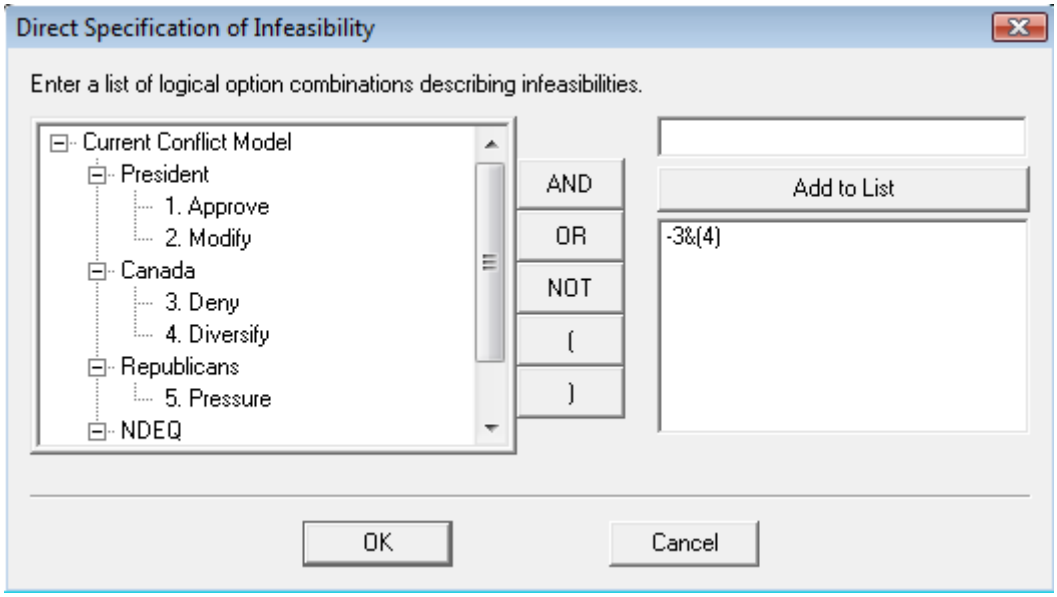
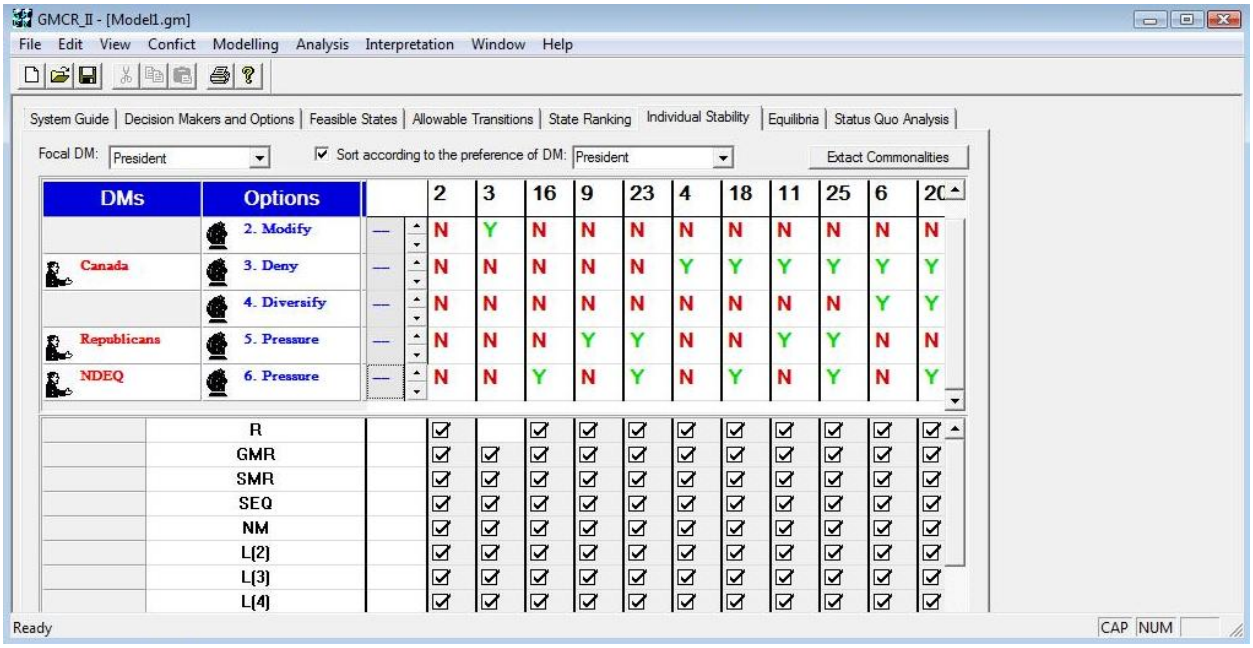
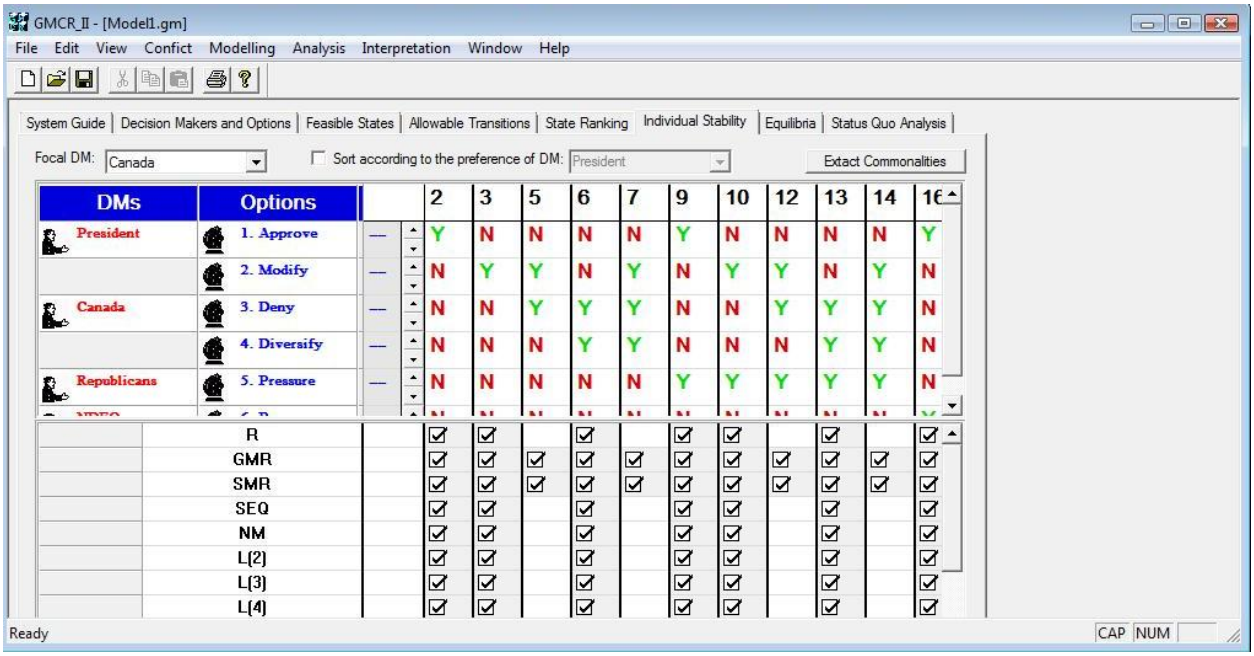


Figure B2. Samples for Individual Stability Analysis for Model Proposed in Chapter 4 Using GMCR II Support System

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Focal DM: Canada
Sort according to the preference of DM: President
Extact Commonalities
DMs
Options
2 3 5 6 7 9 10 12 13 14 16
President
1. Approve
Y N N N N Y N N N N Y
2. Modify
N Y Y N Y N Y Y N Y N
Canada
3. Deny
N N Y Y Y N N Y Y Y N
4. Diversify
N N N Y Y N N N Y Y N
Republicans
5. Pressure
N N N N N Y Y Y Y Y N
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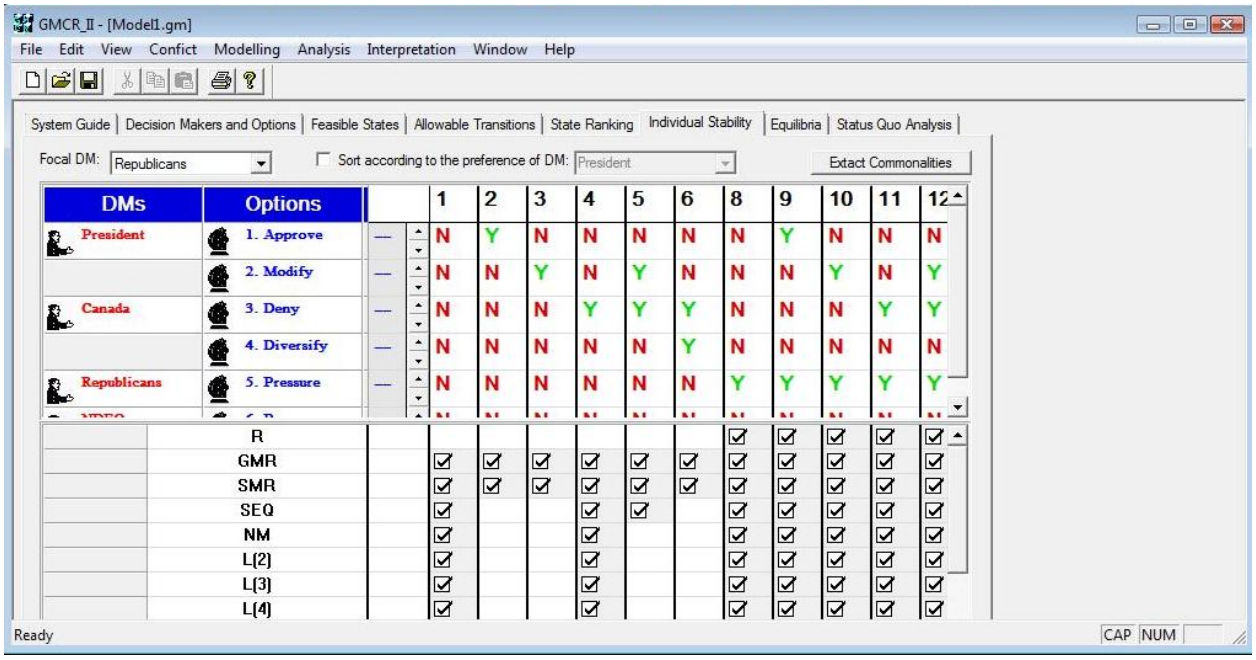
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System Guide | Decision Makers and Options | Feasible States | Allowable Transitions | State Ranking | Individual Stability | Equilibria | Status Quo Analysis
Focal DM: Republicans
Sort according to the preference of DM: President
Extact Commonalities
DMs
Options
President
1. Approve
2. Modify
Canada
3. Deny
4. Diversify
Republicans
5. Pressure
1 2 3 4 5 6 8 9 10 11 12
R
GMR
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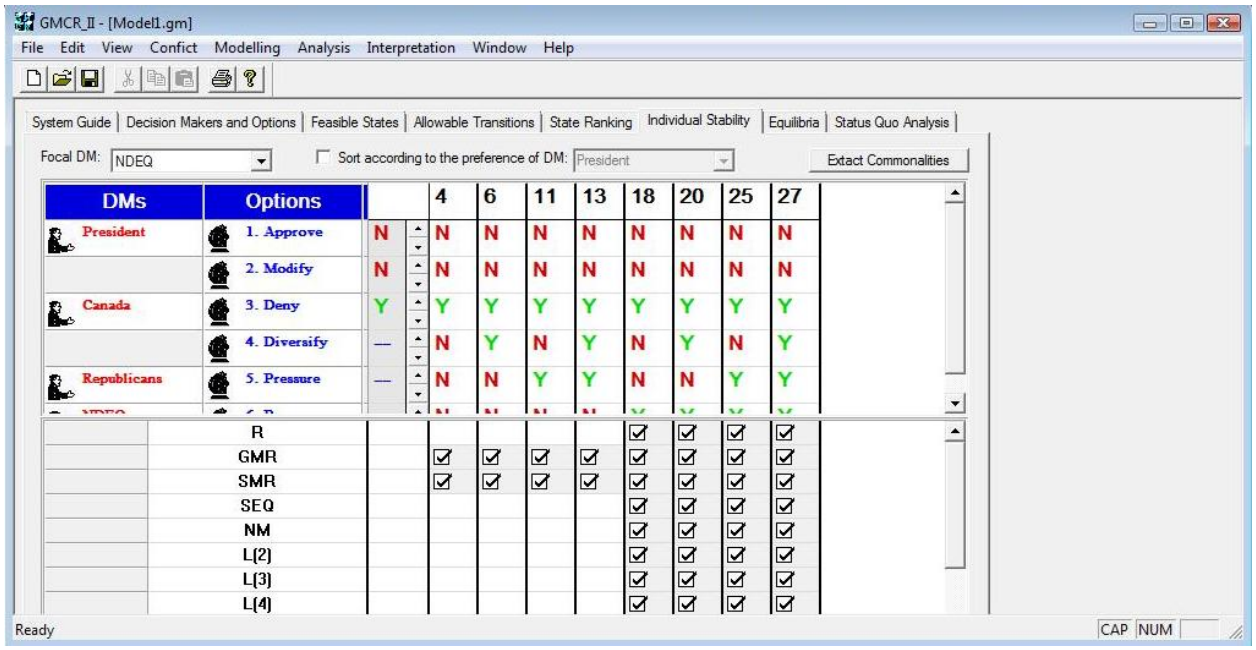
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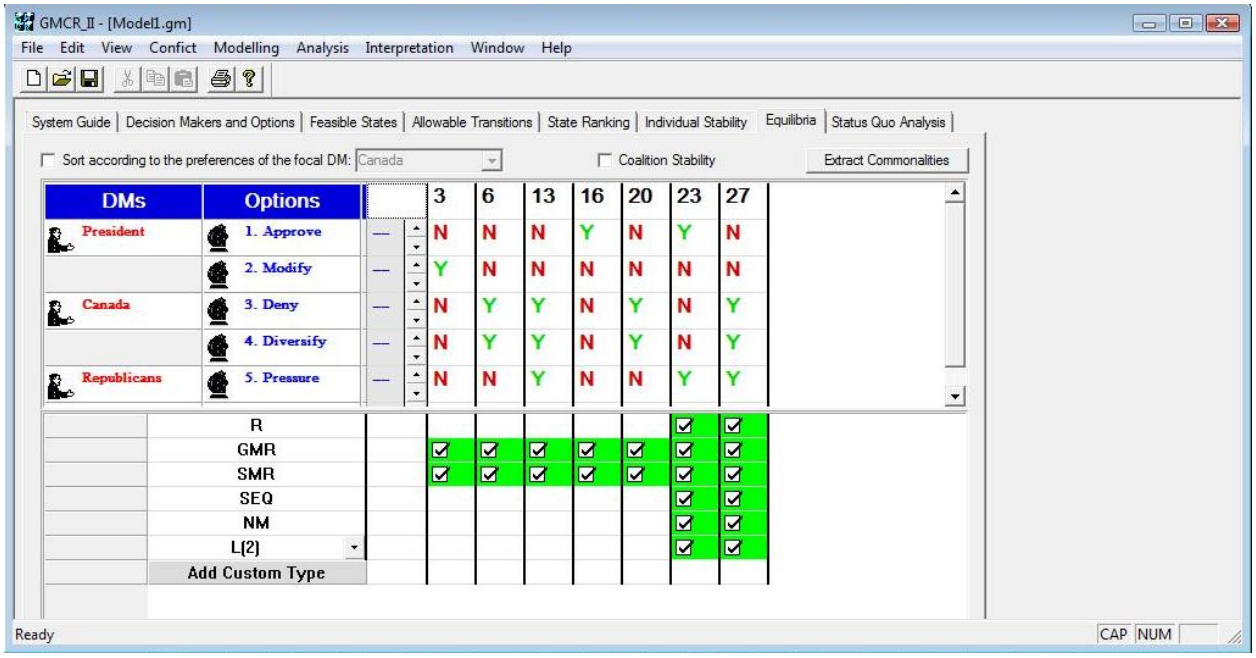
File Edit View Conflict Modelling Analysis Interpretation Window Help
System Guide | Decision Makers and Options | Feasible States | Allowable Transitions | State Ranking | Individual Stability | Equilibria | Status Quo Analysis
Focal DM: NDEQ
Sort according to the preference of DM: President
Extact Commonalities
DMs
Options
President
1. Approve
2. Modify
Canada
3. Deny
4. Diversify
Republicans
5. Pressure
4 6 11 13 18 20 25 27
R
GMR
SMR
SEQ
NM
L[2]
L[3]
L[4]
Ready
CAP NUM

Figure B3. Overall Stability Analysis for Model Proposed in Chapter 4 Using GMCR II Support System



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