UNIT RATE CONTRACTS: IS IT A MODEL FOR OIL SANDS PROJECTS?

By

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Introduction

Canada has vast oil resources and according to the Canadian Association of Petroleum Producers (CAPP) Canada ranks 3rd in the world of provable oil reserves. The majority of the Canadian oil resources are located in the boreal forest of Northern Alberta with over 1.6 trillion barrels of bitumen. There are currently 300 million barrels of oil that are recoverable with today's technology and economic models. (Alberta Enterprise and Advanced Education, 2012)

The economic impact on Canada's economy is equally as impressive. The IHS Cambridge Energy Research Associates (HIS) along with 3 Canadian universities reported that in 2012 the oil sands contributed 480,000 jobs and $91 billion to Canada's Gross Domestic Product. To frame that figure to Canadians the Institute noted that Saskatchewan's economy contributed $78 billion to Canada's GDP in 2012. The group estimates that by 2025 the number of jobs will be near 753,000 jobs and that the oil sand's GDP contribution will be over 5% (Construction Industry Institute , 2009)

The oil sands have been actively producing since 1965. Currently there is approximately $80 billion dollars of capital expenditure planned for the oil sands in the next 10 years. Ernest and Young's (E and Y) 2012-2013 report, on the 10 ten opportunities and risk in the Canadian oil sands, demonstrates that there is an increasing global appetite for oil. E and Y cite that despite increased demands on environment regulations and the constraints around pipeline infrastructure, Canada remains an attractive place to invest. (Ernst and Young, 2012)

E and Y point to cost over runs as one of the largest and highest risk issues that has plagued the oil sands in recent years. The cost over runs on oil sands mega projects has made the rates of return on the projects less attractive than other global petroleum projects. It is common place for oil sands projects to experience a typical cost overrun of 53%. (Ernst and Young, 2012)

Bruce Elliot of Conquest Consulting researched the reasons for the major cost and schedule overruns for Canadian oil sand projects. Several of the reasons and contributing issues for the poor project results were presented in his 2005 presentation at the American Association of Cost Engineers(AACE) International Transactions. Elliot's work was further built upon by Dr. George Jergeas and his 2009 submission entitled "Improving Construction Productivity on Alberta Oil and Gas Capital Projects" that was submitted to Alberta Finance and Enterprise.

The fact that the Alberta oil sector has also been suffering from declining productivity has been highlighted by the Constructions Owner Association of Alberta (COAA). During the period of 2000 to 2007 there was a -8.23 percent decrease in productively in the oil and gas sector. (Jergeas D. G., 2009)

As petroleum technology has grown the oil sands are no longer the only oil project of choice by default. Technologies such as hydraulic fracking and gas to liquid technology have opened up other projects as economically viable. Most recently Suncor Energy canceled the Voyager upgrader resulting in a write down of over $1 billion. One of the reasons cited for canceling the project was concerns about potential cost overruns.

Typically oil sands projects have been executed on a cost reimbursable basis. The project scope is often very fluid. There has also been a significant labour shortage as many of the projects launched at the same time in the early 2000s.

If the Canadian oil sands are going to continue to prosper and be an attractive place for investment, the industry needs to develop long term solutions to deal with the cost overruns on maintenance and construction projects. The solutions need to drive the responsibility of productivity to the contractors and the responsibility of having well defined scopes and schedules be the responsibility of the owners and consulting engineers.

This project will investigate strategies that help provide cost surety to the oil sands construction industries. The project will begin with a review of the historical cost overruns and the lessons learned. The next focus point will be reviewing the demographics of Wood Buffalo to demonstrate the changes that have occurred since the early 2000s and refute the labour availability claim. Following the demographic review we will review construction contracts and the use of good faith as a contractual term. We will then conclude with a review of a unit rate simulation and discussion.

History of Cost Overruns in the Oil Sands

Many oil sands projects have encountered cost overruns and delays. Historically, some fully integrated oil sands mining projects have faced cost over runs of over 55 percent. The overruns have been largely attributable to labour shortages, engineering-related change requested during the construction phase, and the difficulties inherent in managing large-scale projects, particularly those involving upgraders . The oil sands have had a history of increasing cost over runs. In his 2006 study, E.J. Condon found the following data on oil sands overruns:

Figure 1 Costover Runs

Table 1. Cost Overruns on Alberta Oil & Gas Projects (Condon, 2006)

Project	Company	Original Estimate CAD$ billion	Final Cost CAD$ billion	% Cost over run	Original Finish Date	Actual Finish Date
Original GCOS Plant	Suncor	0.25	0.25	0%	1967	1967
Mildred Lake	Syncrude	1.0	2.0	100%	1977	1978
Millennium	Suncor	1.9	3.4	94%	2000	2001
AOSD – Phase 1	Shell	3.5	5.7	63%	2002	2003
UE-1	Syncrude	3.5	7.5	114%	2004	2006

(Condon, 2006)

Beyond the Condon's study, Shells Albian Sands project was originally budgeted at $8 billion and had a final cost of $13.7Billon in 2008. (Donovan, 2008) The trend of cost over runs has continued with the owners beginning to revaluate the feasibility of growth in the oil sands. The end result was that following the economic collapse of 2008 many firms moth-balled projects. The most notable delay was Suncor. Suncor delayed the Fort Hills mine development and the Voyager upgrader citing potential cost overrun concerns. Ultimately in 2013 Suncor elected to divest from the Voyager upgrader with a $1.8 Billion dollar write down as the project was in the beginning phases of construction. The Fort Hills project is going forward but has had a significant increase to the budget and changes to the execution schedule

There has been a noteworthy amount of research on studying the driving forces of the cost overruns. In Bruce Elliot's 2005 presentation to the American Association of Cost Engineers he composed a comprehensive list of the main factors affecting cost over runs in oil sands projects.

Overall Elliot's recommendation was that in order for firms to be successful in estimating the size and scope of oil sands projects there needs to be specific databases that are populated with Northern Alberta data sets that are reviewed by individuals experienced in the oil sands. The development of the databases will allow the owners to more effectively budget the planned scopes of work and hopefully make better decisions in the go or no go process. (Elliott, 2005)

The 2002 study titled "Productivity Improvements on Alberta Major Construction Projects" conducted for the Government of Alberta, Canada found that cost overruns and labor productivity losses on large oil sands projects could be the result of Project Management (McTague & Jergeas, 2002). Jergeas questions if the owners and contractors are effectively managing scope, time, quality, cost, productivity, tools, scaffold, equipment, materials, and leadership.

Rankin conducted a study focused on the impact of detailed execution planning for large oil and gas construction projects and identified a number of reasons causing cost overruns. The reasons included scope creep, insufficient pre-planning, inadequate project controls, and a lack of detailed execution planning. Rankin et al. developed a practitioner's model to assist in implementing detailed execution workface planning for large oil and gas construction projects and suggested that utilizing a fully integrated workface planning model would assist the industry to save money and time. Workface planning is the task of the owner and contractor developing the scope of work into manageable packages (Rankin, Lozon, & Jergeas, 2005). A workface plan is an all-encompassing document that contains all the required information for a specific task such as installing a pump. The workface plan would contain all of the logistics information such as where the pump is located in the project laydown. The package would also lay out step by step what the tasks are to complete the install. The detail would include item such as what the required capacity of the crane to lift the pump is.

The plan would also include an inspection and test plan of all of the quality exhibits that need to be delivered and what steps in the installation would require inspection from the owner or a designated 3rd party. The workface plans also contain all of the critical safety information for the execution of the scope. This can include items such as what safety and operation permits are required to execute the scope. The plan will also specify what site specific training the employees require.

Lozon and Jergeas (2008) studied the application of best practices on large engineering and construction projects by conducting a survey of over 200 industry professionals. The study focused on which practices should be used, when they should be used, and what impact these practices will have on project outcome. Two practices that were strongly recommended by most professionals in the focus groups were constructability and value engineering. (Lozon & Jergeas, 2008)

Constructability is when the engineering firms involve the contractors in the early design phases of a project to get feedback on potential savings through design changes that make execution in the field easier.

Value engineering is focusing on design changes that have savings by changing the design of an element. An example of value engineering would be the push to have more and more modular scope. Modular building has a cost savings as the modules are built in yards located in the south of the province where labour is more readily available.

The study indicated that complacency, constrained funding, and reluctance to investigate alternate construction and contracting strategies can reduce the impact of these reviews to the point where they can increase cost and schedule. Ruwanpura concluded that design/engineering is the project phase which could impact the project most in terms of its cost and schedule. (Jergeas & Ruwanpura, 2009)

Aminah Robinson-Fayek conducted a study to collect and analyze relevant previous data with project starting dates for the period (1990-2003) from heavy industrial construction projects in Alberta. The study also performed two survey questionnaires; one targeted the construction owners and the other targeted the engineering procurement (EP) firms. The main finding of Fayek work was that there is room for improvement in how projects are executed, with problems tending to be more pronounced on larger projects. The study indicated that collecting historical data was found to be an inefficient process and that future project performance studies should be based on sound benchmarking systems that collect data in a timely manner as projects unfold, and on an industry-wide level. The study provided suggestions for steps to control cost overruns and performance deviations on major industrial construction projects. (Fayek, Revay, Rowan, & Mousseau, 2006)

George Jergeas studied the delivery of mega oil sands projects in Alberta. The research focused on front-end loading, early engineering effort, and change to scope during the early stages of the project life cycle after the appropriation for expenditure (AFE). His findings indicate that few of the early design milestones could be achieved on time and this is mainly due to scope changes and the stream of trends. (Jergeas D. G., 2009)

Aminah Robinson-Fayek studied the impacts and benefits to the various parties involved in industrial construction caused by increasing the utilization of apprentices on industrial construction projects. A pilot study was conducted on a major industrial project to help in quantifying the impact of the use of apprentices in the industrial construction sector and to identify methods of effectively increasing their use while simultaneously enhancing their on the-job learning experience. The project was piloted on a major industrial construction project in Alberta. The project consisted of a 150 000 barrel per day bitumen upgrader. Pipefitters and electricians were chosen for the pilot study because they are two of the most significant trades in industrial construction. Fayek's main finding was that apprentices can be effectively incorporated in industrial construction, and they can be both productive and cost-effective, provided they are given adequate instruction and supervision. (Fayek, Shaheen, & Oduba, 2003)

Fayek conducted a study to provide an overview of the recent advances and initiatives in workforce training in Alberta within the unionized building trades sector of the industrial construction industry and to highlight the economic significance of these initiatives for mega construction projects. The research was conducted on optimizing the utilization of apprentices in the industrial sector. The study indicated that Alberta has been at the forefront of workforce training, largely as a result of the unique demand for huge numbers of skilled workers for simultaneous mega projects. The initiatives developed in Alberta, such as the apprentice-mentoring and supervisory development programs, can be used as a model in other jurisdictions. Taking these programs to a national level would have significant benefits for Alberta and other provinces, as the construction forces are very mobile. For example, the mega projects in Fort McMurray, Alberta, are heavily dependent on workers from other provinces, not just Alberta. (Fayek, Yorke, & Cherlet, Workforce training initiatives for mega project success, 2006)

Additionally, the Construction Owners Association of Alberta (COAA) publications provide a useful reference for elements relating to construction productivity in the oil and gas sector. These documents are construction execution planning, engineering and field rework, and overtime best practices in addition to the workface planning model. (Construction Industry Institute , 2009)

Lessons Learned

In his 2009 study Jergeas indicated that while major oil sands projects are successful from an engineering, operational, and safety standpoint. The cost and schedule overruns are a cause for concern and needs attention in many areas including construction productivity. (Jergeas D. G., 2009) It has also been highlighted in the work of Jergeas and Elliot listed several of the reasons and contributing issues for the poor project results and the major cost and schedule overruns for Canadian oil sand projects. Elliot provided the following reasons:

- Lack of experienced owner and contractor resources
- Overall quality of owner and contractor management capabilities
- Ineffective organizational and alliance structures for megaprojects
- Inappropriate delegation of owner responsibilities to contractors
- Lack of clear definition of lines of authority and management responsibilities
- Lack of discipline and ineffective control of project scope
- Complexities of major expansions to existing operating plants

• Customization of owner specification requirements

• Level of project definition and complexity not well understood

• Lack of familiarity with the northern Alberta climate, safety requirements, environmental constraints, government regulations, construction practices

• Scarcity of qualified craft workers, high labor costs, inconsistent productivity

• Many competing mega-projects affecting resources and labour availability

• Ineffective contractual arrangements and lucrative contracting environment

• Ineffective material management plans and premature field mobilization

• Inappropriate management influence of cost estimates to meet economic hurdles and ignoring project reality

• Ineffective project control systems and project development practices

• Lack of discipline and consistent application of project code of accounts to allow effective control and collection of actual costs

• Lack of owner front-end estimating capability and project control personnel

• Lack of appropriate risk analysis expertise

• Lack of owner estimate review and validation expertise

• Lack of owner historical project systems and databases which reflect northern Alberta Conditions

George Jergeas has done extensive research on the oil sands and has developed a frame work that demonstrates the early warning signs that a project is going to have overruns. The first warning sign is delays in engineering. The early warning can be seen in delay in meeting key milestones. The milestones include substantial completion of engineering, completing and freezing the process and flow diagrams and issuing the drawings. The major issue that Jergeas points to is that the delays in engineering are often not reflected in the overall project schedule. The end result is that the fast track project then gets fast tracked (Jergeas & Halari, Lessons Learned from the Execution of Oil Sands' SAGD Projects, 2012)

The second early warning sign is indicated by a number of trends or increases in key quantities which then lead to a project re-estimate. Trends are designed to flag an individual activity change but they are more like the tip of an iceberg. The trend may be an increase in the amount of grout but the change may be driven by a much larger issue. The subsequent project estimate indicates a higher level of cost variation than would be expected from the trend. An example would be an increase in grout quantities which alone are not that big of an issue but the factor driving the trend is a change in pumps that will require much more work to install.

Trends can be delineated in four ways. Trends are driven by design development, changes to the estimate, estimate omissions, or changes in execution strategy (Jergeas & Halari, Lessons Learned from the Execution of Oil Sands' SAGD Projects, 2012)

Contingences and Allowances

The third early warning sign that a project may have issues is that with a large volume of trends the contingencies and allowances will soon prove to be inadequate. The issues with contingencies is the final warning sign to the project management team that the execution of the project may not be going as planned (Jergeas & Halari, Lessons Learned from the Execution of Oil Sands' SAGD Projects, 2012)

Demographic of Wood Buffalo

The regional municipality is one the most exciting communities in Canada. The region is the hub of Canada's heavy oil production. With recent improvements in oil extraction technology the region has become one of the fastest growing communities in Canada. The growth has sparked an economic boom with doubled digit annual population growth for the last 15 year and potential to continue for the next 15. Unfortunately the growth has come at a huge environmental and social cost. We will review the demographic structure, economic and social structure, major industries, opportunities and challenges facing the regional municipality as it continues to grow and prosper and at times stumble with uncontrolled growth cycles.

Demographic Structure

The demographic structure of the regional municipality is quite contentious. The federal census published by Statistics Canada does not count people who do not consider Fort McMurray to be their primary residences. The issue is that many of the people spend over 80% of their time in the regional municipality. They use all of the services such as sewage, health care, and highway infrastructure but because of the methodology the government uses to determine funding this adversely affects funding for projects for the community. Below is a table from the 2012 municipal table representing the disparity in the total population of the regional municipality

Figure 2 Regional Census

	2010 Municipal Census[13]	2011 Federal Census[14]	2012 Municipal Census[15] (extrapolated to a 95.5% completion rate)	2012 Municipal Census (extrapolated to a 100% completion rate)
Urban Service Area[16]	76,797	61,374	72,944	76,009
Rural Service Area[17]	4,216	4,191	4,192	4,216
Project Accommodations[18]	23,325	N/A	39,271	39,271
Total	104,338	65,565	116,407	119,496

(Regional Municpality of Wood Bufflo , 2013)

The municipality has experienced a doubling of residents and other non-residents using the resources of the community since 2000. The population growth has been driven by the rapid pace of development of the oil sands. The community has experienced major growth cycles in the past as demonstrated in the Statistics Canada table below.

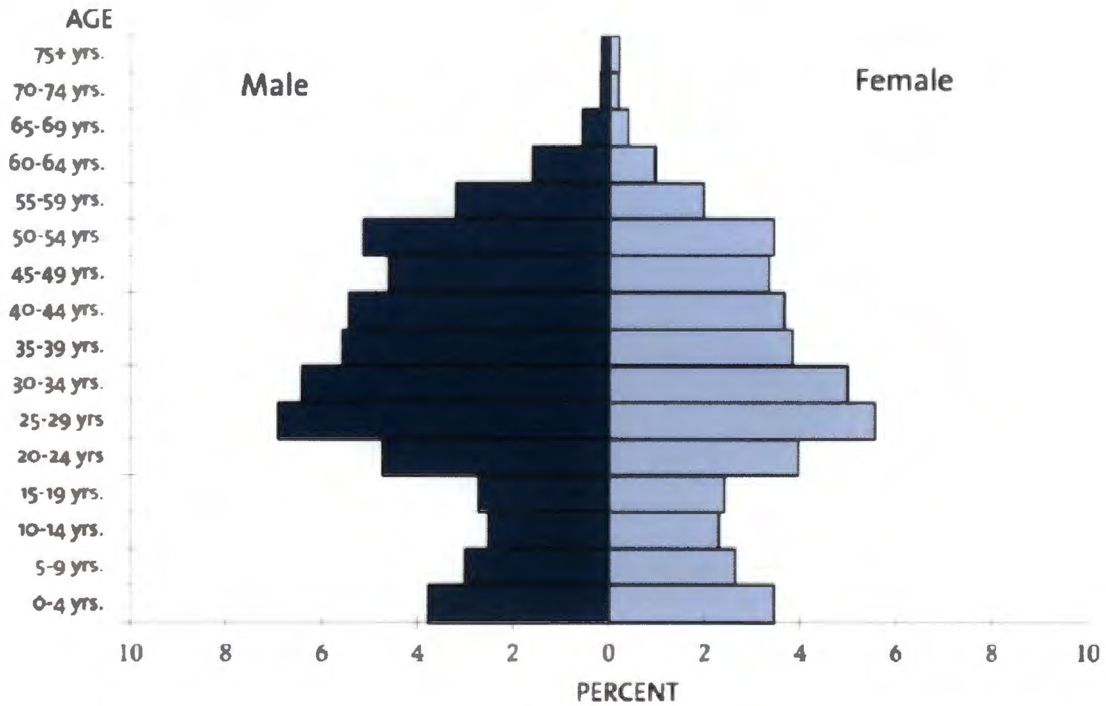
Figure 3 Population history

Population history RM WOOD BUFFALO		
Year	Pop.	±%
1951	926	—
1956	1,110	19.90%
1961	1,186	6.80%
1966	2,614	120.40%
1971	6,847	161.90%
1976	15,424	125.30%
1981	31,000	101.00%
1986	34,949	12.70%
1991	34,706	−0.7%
1996	33,078	−4.7%
2001	38,667	16.90%
2006	47,705	23.40%
2011	61,374	28.70%

(Statistic Canada , 2007)

The current growth projection as presented in the 2013 Municipal budget, estimates that by 2016 the municipality will have a population 156,000 residents and non-residents with 27,000 being non-residents in project accommodations. (Regional Municipality of Wood Buffalo , 2013) The large non-resident population, who are over 90% male, has led to a population pyramid that is heavily skewed towards young men. This stacking of young men has led to a lot of the stereo types associated with the community and has also contributed to a lot of the social issues surrounding high risk sexual behavior and drug use.

Figure 4 Population Vs Age



(Regional Municpality of Wood Bufflo , 2013)

Observing the municipal census note that the population pyramid is 57% Male to 43% female.

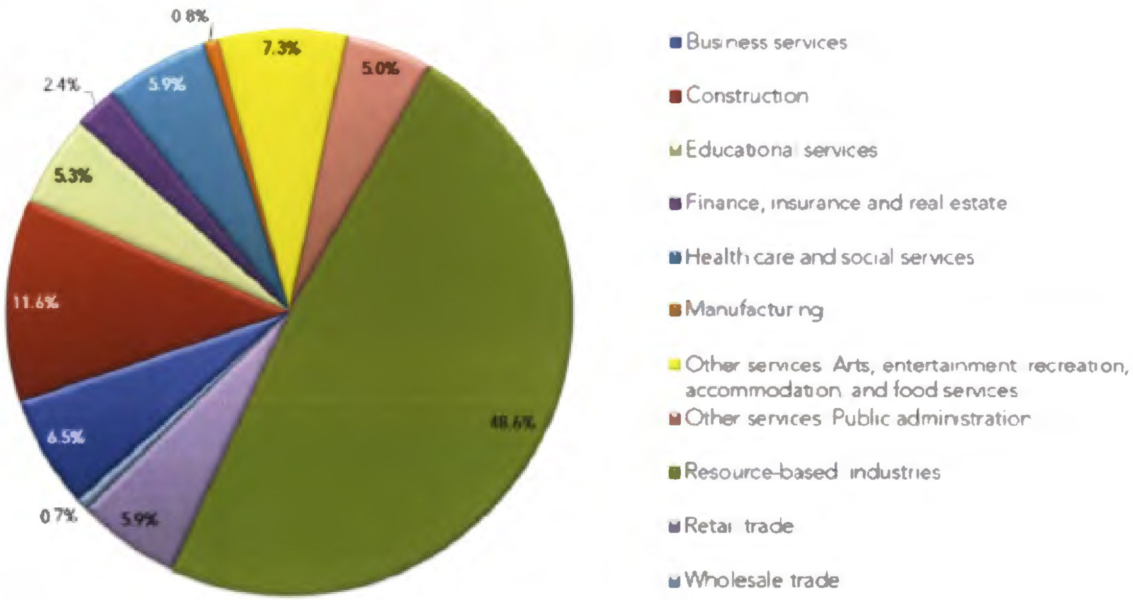
The municipality is home to a surprising number of diverse ethnic and cultural groups when compared to other northern communities such as Prince George. In the region of Wood Buffalo 1 in 4 residents describe themselves as visible minorities. Of the 25%

less than 6% describe themselves as First Nations. Of the residents who list themselves as Canadian born 56% claim Alberta as their province of birth. One of the surprising facts is that 22.5% of the remainder describe themselves as originating from Atlantic Canada. The largest portions of the 22.5% originate from the Province of Newfoundland and Labrador at 15.2%. The next largest region of origin is the Province of Ontario at 7.8% (Regional Municipality of Wood Bufflo , 2013)

Economic and Social Structure

The economic and social structure of the regional municipality is largely dominated by the oil industry. The 2012 census discovered that the oil industry accounted for nearly half of the employment in the region. The heavy dependence on the oil sands as the only industry means that the community is at risk for boom and bust cycles. Another issue is that the dominance of heavy industry makes it very difficult for non-oil business to succeed given the high demand for very limited commercial space resulting in higher rates per square foot lease rates than compared to that of Edmonton and Calgary

Figure 5 Employment by Industry 2013



(Regional Municipality of Wood Bufflo , 2013)

Employment in the oil sands has generated some of the highest household incomes in Canada. It is estimated that the 2010 median house hold income in the region was $177,010. (Regional Municpality of Wood Bufflo , 2013) One of the adverse side effects of such high incomes is that the averaged detached family house in the regional municipality lists for $792,000. The economic reports find that the average family disposable family income is $131,287. (Regional Muncipality of Wood Buffalo, 2011) People who are below average income have an increasingly hard time meeting their basic needs in the community. In the municipality's census the non-residents were polled as to what was the reason was they do not live permanently in the municipality and the lack affordable housing was number one for 78% of respondents. (Regional Municpality of Wood Bufflo , 2013) The high income combined with the average age of 32 has led to a boom in single family houses. The municipality found that 75% of the people were married or in long term partner ships. The level of attainment of higher education exceeds the provincial average. Due the influence of heavy industry there is more than double the provincial average in trades and associated training. These educational attainment results are opposite to the common view that Fort McMurray is full of uneducated blue collar workers

Figure 6 Educational Attainment 25-35

Educational Attainment – 25 to 34 year olds

	Wood Buffalo	Alberta
No certificate, diploma or degree	11.2%	13.6%
High school certificate	22.7%	24.4%
Apprenticeship or trades certificate or diploma	18.5%	9.8%
College, CEGEP or non-university certificate or diploma	26.2%	22.2%
University certificate, diploma or degree	21.3%	30.0%

Source: Statistics Canada 2006

Major Industries

The municipality has a long history of involvement in the resource industry. Prior to oil extraction it was home to most of Western Canada's salt production. (Hein, 2005) Oil was first noted by the Europeans in 1719 when a sample was provided to the manager of York Fort by a Cree guide named WA-PA-SU. In 1778, the oil sands were confirmed by one of the first Europeans in the area a trapper named Peter Pond. In 1870 the Hudson's Bay Company established a trading post at the confluence of Clear Water and Athabasca Rivers. The trading post was named Fort McMurray in honor of William Murray a strong proponent of the Hudson's Bay Company. The fur trading business had collapsed by the turn of the century but Fort Murray continued to prosper as it was part of the only access to the Northwest Territories and the Arctic. Fort McMurray was used as a ship yard and warehousing facility. In 1906 there was an attempt to find free oil via drilling, this was unsuccessful but salt was discovered. In 1925 the first salt mine was operational. The mining was done via pumping hot water into a drill hole and pumping the salt brine up and drying it. Salt mining was the main industry in Fort McMurray until 1950. (Hein, 2005)

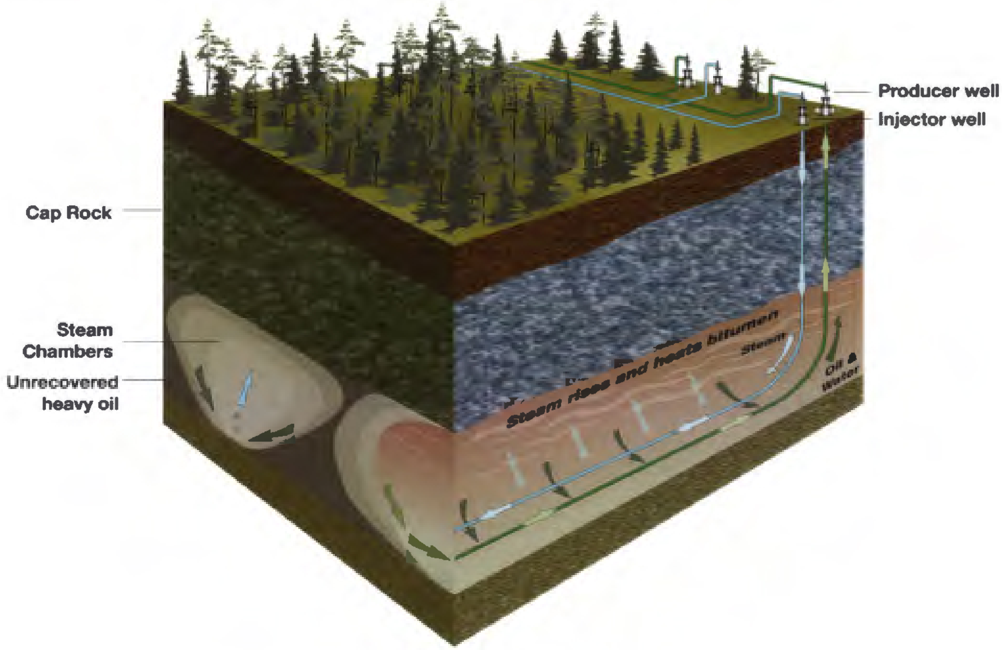
Figure 7 Historical Picture 1935

1938: Abasand Oils Ltd., the first commercial oil project, begins producing diesel from the oil sands. A photo of the Abasand camp at Horse River, Alta., taken in 1936, shows the mess hall and bunk house in the left background and the separation plant at right. It was sold to the government after WWII and not rebuilt after it subsequently burned down.
(/National Archives of Canada / Canadian Press)

(Hein, 2005)

The first two attempts at oil extraction were done at pilot plants. One plant was built in the Abba sand area and was operational until 1945 when the plant was destroyed by fire. In 1929 a pilot plant was constructed in Bitumount (approximately 50km north of Fort McMurray). The Bitumont plant would prove that the technology for extracting oil on a large scale was feasible although at the time uneconomical. All of the initial projects focused on mining the oil sands. At first bucket wheel technology was used as opposed to the technique of shovel and haul trucks as is now used. In 1962 the Great Canadian Oil Sands Company (GCOSC) received permission to build a 31,500 barrel per day extraction plant at Tar Island. The plant opens in 1967. GCOSC was owned by the Sun Oil Company of Pennsylvania. The company would eventually become Suncor. In 1969 a second plant was approved in the region. The second plant was owned by a consortium of oil companies and the pure play project was known as Syncrude. (Hein, 2005) The Syncrude facility was opened in 1978. The oil sands struggled with technological, economic, and policy issues for the next 15 years and saw little growth. In the late 1990's Shell Canada opened a 3rd mine known as Muskeg River Mine. By the mid-2000 a 4^{th} mine was constructed by Canadian Natural Resources Limited (CNRL). In 2013 Imperial Oil opened a 5^{th} mine at their Kearl Lake facility.

Figure 8 SAGD Process



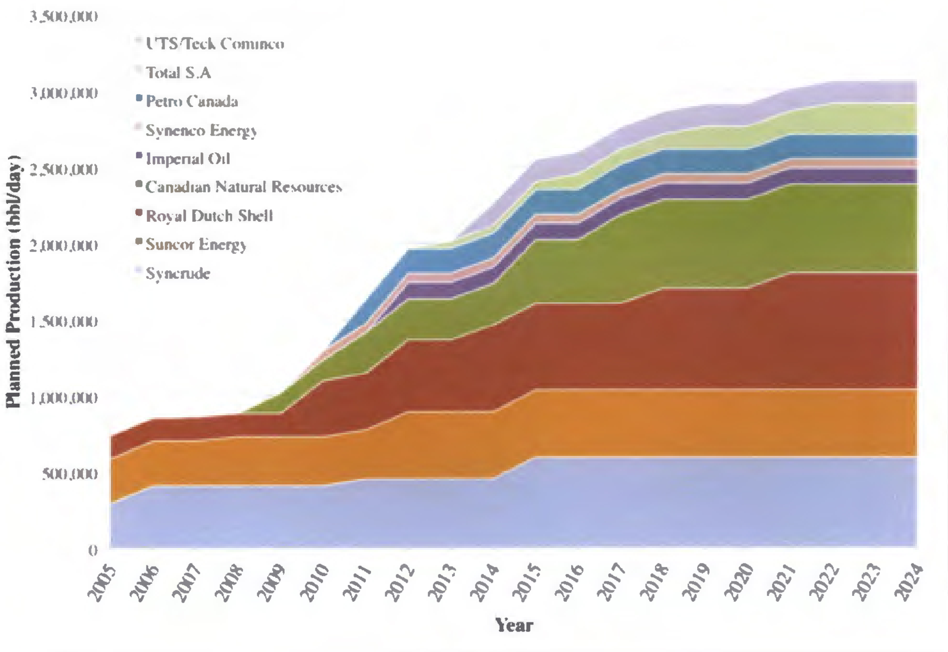
(The Oil Sands Developers Group, 2013)

Most of the oil sands are too deep to make mining economical due to the amount of overburden that needs to be stripped to access the oil sands. A process called in situ is used (show above). Outside of the industry and in regulatory documents the process is referred to as Thermal. The process in lay terms is that 2 wells are drilled. One well is pumped full of steam to heat the ground the other well is drilled directly below and sucks the now fluid bitumen out of the ground. During the mid-1980 there was push to develop the deeper oil sands and subsequently a number of experimental plants were put into operation to perfect the process. Most notably was Petro Canada's MacKay River project. In the early 2000's Suncor and Opti-Nexen successfully completed two large scale in-situ projects. The majority of the future development in the oil sands will be at in-situ thermal projects. (The Oil Sands Developers Group, 2013)

Today the only major industry in the area is the extraction of oil. Originally the mines were the major players in the economy. As the technology surrounding directional drilling improved in the late 1990's the thermal projects quickly became economical.

This led to a major boom in the oil sands. As shown production has tripled since 2005 and is expected to increase by 1,000,000 bbl. per day end of the decade.

Figure 9 Oil Production Forecast



(Regional Muncipality of Wood Buffalo, 2011)

Opportunities

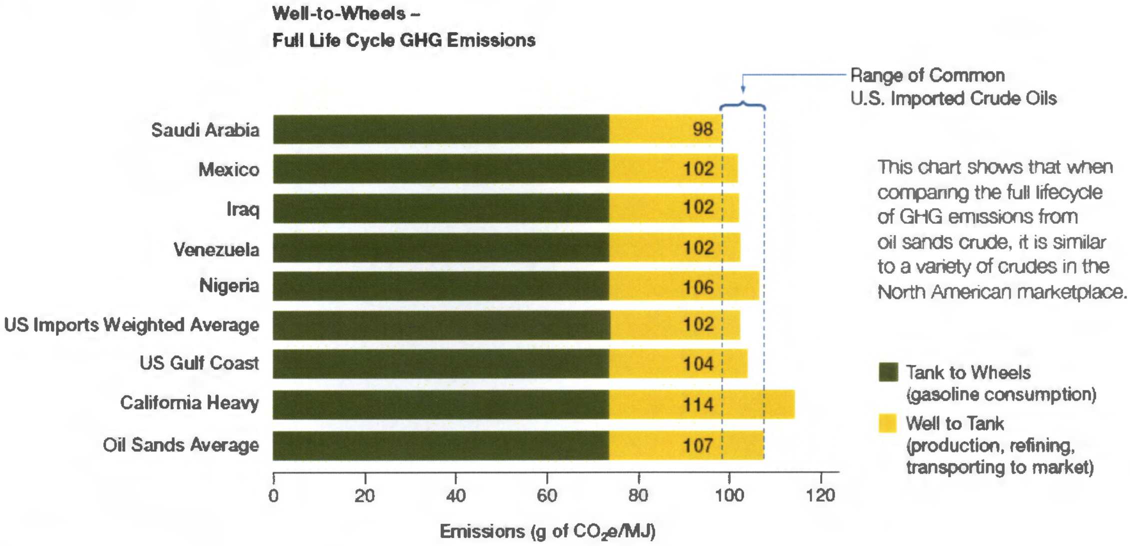
The economic opportunities for the municipality are huge. The growth of the community has meant that the region draws people from all over Canada. Traditionally employment growth has only been in the oil sectors but now there is growth in non-related fields such as education and health care. People from the depressed regions of Canada have an opportunity to ply their trade in fields such a teaching, social work, and the arts. There has been many news stories regarding the rise of Fort Mcmurray and a new class of young educated McMurrratires who travel the world, own their houses, and have established careers while their urban counter parts are still living at home and working part time jobs. Recently the community was named as the best place for business by Alberta Venture magazine.

Challenges

The challenges faced by the region are numerous. The challenges can be categorized as social or environmental. The social issues represent major challenges for the community and Northern Alberta. Unfortunately of the 2 issues the social ones are the most difficult to solve. The environmental issue although having impacts on the entire world seem to have technological solutions. The majority of the social issues can be linked to the influx of people into the region. This has severely taxed the physical infrastructure but also ancillary social services. Highway 63, the only route to Fort McMurray has experienced over 158 fatal accidents since 1990. (Edmonton Journal , 2013) (Austen, 2013). The highway is currently being twined but the project is not expected to be complete until 2015. There are major issues with income inequality as high housing prices have made it almost impossible for anyone not involved in the oil industry to survive. The poverty line for the average family of 4 is listed as being $93,000 per year. The effect of such a high poverty line makes it difficult for services and support industries to retain staff. The effect has been significantly felt in health care where there has been a 150 percent turnover in nursing staff. As a result the Northern Lights Regional Hospital has had below average heath care statistics and was labeled by the CBC in 2013 as being one of the nation's worst hospitals. Assaults in Fort McMurray are reportedly 89 percent higher than in the rest of Alberta. Arrests for drug-related offences are 215 percent higher, and arrests for impaired driving 117 percent higher than those recorded elsewhere in the province.

The environmental impact of the oil sands is profound. The oil has been dubbed dirty oil by the media and the concept of dirty oil rose to prevalence in Al Gore's documentary An Inconvenient Truth. In the documentary Gore gave the analogy that the oil from the oil sans will required 4 joules of energy to create one joule of 1 oil energy. He also quoted the well to well graph that was accurate at the time but technology has since changed and the current wells to wheels graph is shown below.

Figure 10 Well to Wheels GHG Graph

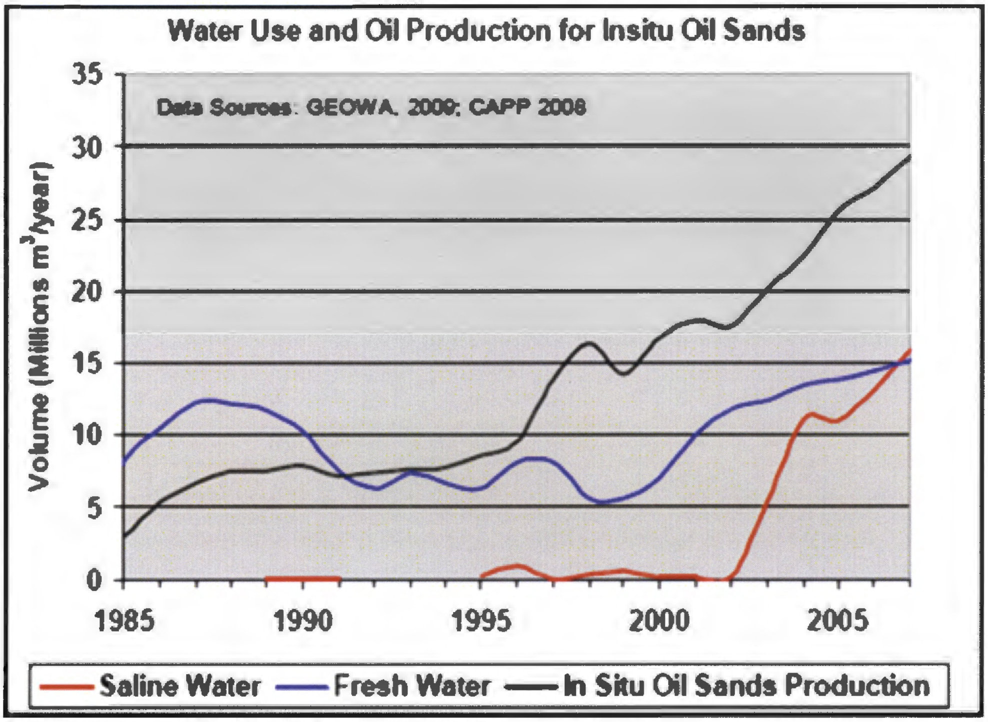


(Alberta Goverment , 2013)

As the technology matures confidence grows that the oil sands will be on target with conventional oil in terms of their emissions growth. The greenhouse gas emissions have doubled since 1990 and have since growing at an alarming pace. Canada's total emissions grew by 103 Metric Tons (Mt) between 1990 and 2010, with oil sands emissions were responsible for 32 per cent (33 Mt) of this increase. According to Green Peace the oil sand emit more greenhouse gases (GHG) than some small countries and by 2020 the oil sands will emit more GHG than Belgium or Ireland. In 2013 the Syncrude project was listed as Alberta's largest emitter of Greenhouse house gases. A 2012 study by Queen's University found that carcinogens have been found in some case as much as 23 times higher than were known previously when compared to samples from the 1960's before major development of the oil sands. (Austen, 2013)

Water use in the oil sands has always been a major concern. Each barrel of oil produced requires an estimated 0.71 barrels of water to be involved in the process. The technology has changed allowing basil saline water to be used but the growth of the thermal projects means that more and more water will be required.

Figure 11 Water Use and Oil Production



(Construction Industry Institute , 2009)

The inclusion of saline and recycling of fresh water comes with its own risks as Suncor discovered in 2013 when a process water line broke and leaked into the Athabasca River.

Construction Contracts

Reviewing the five main types of construction contracts used in industrial petro chemical projects (Parra Diaz, 2008). The goal is through investigation to try and determine which contract type will best suit the challenges that are present in Northern Alberta. The largest issue at hand is solving the issue of how productivity can be improved while mitigating the risk premium that the owner is paying. Identifying and managing risk is the first step to determining how to price the risk. One of the main elements of construction contracts is how they address the pricing of profitability risk.

Risk

Defining risk is a key component of what differentiates a successful project from a problem project. The goal of project management is to create a barrier between the external environmental factors that can affect a project. The other goal of project management is to create a barrier of change prevention. The source of change can be the influence of corporate management. The culture of the conventional risk management has created a climate of risk aversion (Jergeas & Halari, Lessons Learned from the Execution of Oil Sands' SAGD Projects, 2012).

The project risk model is one that delineates between the over laps of corporate management, the environment and project management.

Figure 12 Risk Types

(Jergeas & Halari, Lessons Learned from the Execution of Oil Sands' SAGD Projects, 2012)

The risk model provided by Jergeas shows that the overlaps have specific risk associated.

Operational Risk

Operation risk is defined as threats with a potential impact on the project resulting from actions that are controlled by the project manager. Examples of operation risk are items like lunch room lay out or hours of work.

Strategic Risk

Strategic risk is defined as threats with a potential impact on business objectives due to decision by management. Examples of strategic risk could be the decision to have an open shop or procure modules fromSouth Korea.

Contextual Risk

Contextual risk are threats with a potential impact on business and projects objectives imposed by circumstances beyond the control of project management and corporate management. Examples of contextual risk would be government policy or labour availability.

Each risk category has a party who is responsible for the visibility, accountability, and ability to manage the risk. Jergeas points to strategic and contextual as being addressed by corporate management decisions. He points to operational risks being addressed by the project team who have both the authority to make decisions and who are also clearly accountable for the end results.

Risk in a project can be covered in 3 ways. Risk can be covered via operational risk, strategic risk, and contextual risk. Contingency is used to cover the operational risks. Scope allowance is used to cover the strategic risk and finally a management reserve is used to cover the contextual risk (Jergeas & Halari, Lessons Learned from the Execution of Oil Sands' SAGD Projects, 2012)

Contract Types

The five main types of construction contracts are: time & materials, management fee, target cost plus incentive, unit rate, and lump sum.

Contracts are the foundation of how a project is going to be executed. The contract sets the tone of the project and also provides the legal framework for the execution of the scope and defines the roles and responsibilities of the contractor owner and any third parties. The relationship between the owner and contractor can have a cooperative nature or adversarial nature depending on the type of contract selected. The style of the contract ultimately gets communicated to the craft and can have a huge impact on the productivity, safety, and quality culture of the job. The reason there are so many types of contracts is that each type of contact has its own inherent strengths and weaknesses that can be used to solve the issue at hand. The issue is that each contract type has contractors or owners who may be stronger in one form of execution versus another. The challenge is to pick the contract type that will deliver the best value to the owner while mitigating the risk exposure given the constraints of engineering, budgets, competiveness of the contractors,(oxford comma) and labour availability.

Time and Material

Time and material construction contracts are commonly referred to in industry as cost plus. The execution of cost plus contracts put all of the risk in the hands of the owner. Typically the contractor will develop a schedule of rates that are inclusive of all of the cost of the employee. The contractor will also establish a cost schedule for rental of contractor owned equipment. The contactor will also establish a schedule of rates for the reimbursement of 3rd party services, material and supply. The contractor will then negotiate a fee on top of the cost. The fee ranges typical ranges from 2 percent to 10 percent but can be as high as 15 percent or 20 percent. Often there is hidden profit in the rate schedule. This can include items like small tools and consumables. Typically the contactor will advise the owner that the cost of managing small tools and consumables on a cost reimbursable basis is too much work for the return. The contractor will then propose an hourly adder as an allocated cost. There is the opportunity for the contractor to reap the rewards of the hourly adder by managing small tools and consumables for profit on top of the already negotiated cost plus aspect. Cost plus contracts gain popularity in the 1970's and 1980's on major global industrial projects. The thinking at the time is that the cost plus approach to contracts would create a win-win environment where the contracts would have limited risk and the owner could have the project built for somewhere near the estimated price. The issue with cost plus contracts is that there is an agency theory issue that is not openly addressed. The contractor makes more money by having more expenses on the project. As there is no risk for the contractor as they simply push the control and management onto the owner. In many cases engineering firms and owners typically hire a construction management team to manage the contractors directly. The Construction management team are often contactors themselves. The stacking of contractors managing other contractors is a management nightmare with the interest of the owner often not having a voice. Ultimately issues surrounding cost over runs related to productivity is blamed on the owner for issues like safety or cooperate policies. The issues are easy scape goat but fundamentally the issue is the agency theory related with the contractor making more money by having more employees and therefore expense (Parra Diaz, 2008).

Advantages

Set a contract early with little negotiation.

Work definition is unimportant to contract.

Selection of supplier is based on rates.

Disadvantages

Owner assumes all of the risk.

Owner usually has to drive productivity

Owner has to manage all coordination issues.

Owner carries cost of poor quality.

Supplier can take longer and use more people.

Final cost certainty can be low.

Management Fee

Management fee contracts are where the owner will engage a firm to manage the scope of work for a fixed fee. The actual scope of work will then be subcontracted to a third party who may or may not be associated with the management contractor. The subcontract would be a unit rate, cost plus or lump sum project. The advantage of the management fee approach is that it allows the owner to hire a firm whose expertise is construction project management. As with time and material contracts the risk is taken on by the owner and the management fee is also exposed to the same agency theory pitfalls as the cost reimbursable contract.

Advantages

Set a contract early with little negotiation.

Work definition is unimportant to contract.

Selection of supplier is done by experts with construction expertise

Disadvantages

Owner assumes all of the risk.

Owner usually has to drive productivity

Owner has to manage all coordination issues.

Owner carries cost of poor quality.

Supplier can take longer and use more people.

Final cost certainty can be low.

Target Cost Plus Incentive

The target cost plus incentive method of contracts is where the owner will try and set what they felt to be a fair price for the project if it were to be executed in a lump sum manner. What is then done is they will then do is hire a construction firm to perform the scope on a cost plus method. The contractor will complete the scope and any charges that are less than the target price would be shared between the owner and the contractor at a predetermined rate. Typically the share is 50 percent going to each party. An example of this would be if the target price of projects was $1,000,000 dollars and the contractor executed the scope on a cost plus contract for $800,000. The $200,000 under the target price would be shared between the contractors and the owner, under the 50/50 split this would mean that the contract could get $100,000. This type of arrangement is difficult to enter as the circumstance required having the scope defined well enough to determine the target price in a fair manner would beg the question why would the scope not be executed under a lump sum contract. Significant changes in scope may result in the target price either rising or falling. The negotiations around this can be just as difficult as with changes in lump sum contracts.

Advantages

Set a contract early with little negotiation.

Work definition is unimportant to contract.

Savings is shared between he owner and contractor.

Incentive to keep project cost down .

Disadvantages

Owner assumes all of the risk.

Owner usually has to drive productivity.

Owner has to manage all coordination issues.

Owner carries cost of poor quality.

Supplier can take longer and use more people.

Final cost certainty can be low.

Unit Rate

Unit rate contracts are when the scope of a project may be unknown but the owner will have the contractor provide a unit rate. The units may be cost per cubic meter of concrete of a ton of steel or may by the price per unit for a system. The advantage of the unit rate is it allows the owner to tie the contactor to a price that allows for changes. Often there will be clauses in the contract that will allow the contractor to negotiate the contract rates if the amount exceed plus or minus 20 percent of the initial unit. The work of Nazilli and Posravaru has shown one of the weaknesses of unit rate contracts being the reconciliation of quantities. Their work on a relatively simple civil project showed that the contractor had difficulty getting paid as they had issues delineating between the different concrete form types and invoicing them correctly. The requirement for experience project controls and cost accounting teams on both the owner and contractors side are critical for the success of unit rate construction. (Nazilli & Postavaru, 2012)

Advantages

Contract can be set fairly quickly.

Good for discrete accurate packages of work.

Increased possibility of known cost.

Contract is based on agreed rates.

Disadvantages

Work definition must be very good to maintain expected cost.

Owner must manage delays to avoid additional cost.

Owner pays for risk up front.

Owner probably pay's for all coordination issues.

Owner pays for any work management issues significant likelihood of extras if scope definition is weak .

Lump Sum

Lumps or fixed price contracts are negotiated when the scope and specification of the project are very well defined and not expected to change throughout the projects. Lump sum contracts are advantageous in that they allow the owner to know with some certainty what the final price of the project will be. The benefit for the contactor is that they can target a margin and with improved productivity they can effectively increase the margin. The difficulty with lump sum projects is that they need to be very well defined with minimal or no change occurring throughout the course of construction. The risk of productivity is taken on by the contractor. Given that the contactor is taking on the risk they will adequately price the risk with the result being that the contractor may charge more for the risk premium than the actual construction cost and reasonable risk premium. From the owner perspective it may also be difficult to control the contract if the scope and specification was not well defined. This issue is very relevant where quality is concerned. Unless the contract documents were specific about quality the contractor will use any changes in specification as an extra work item. Disputes around lump sum contracts can be very complex and time consuming. Lump sum contracts are typically reserved for less complex infrastructure project and commercial projects and less in industrial projects where there is the risk of scope and specification change.

Advantages:

Contract can be set fairly quickly.

Good for discrete accurate packages of work.

Increased possibility of known cost.

Contract is based on agreed scope for a fix sum.

Disadvantages

Work definition must be very good to maintain expected cost.

Owner must manage delays to avoid additional cost.

Owner pays for risk up front.

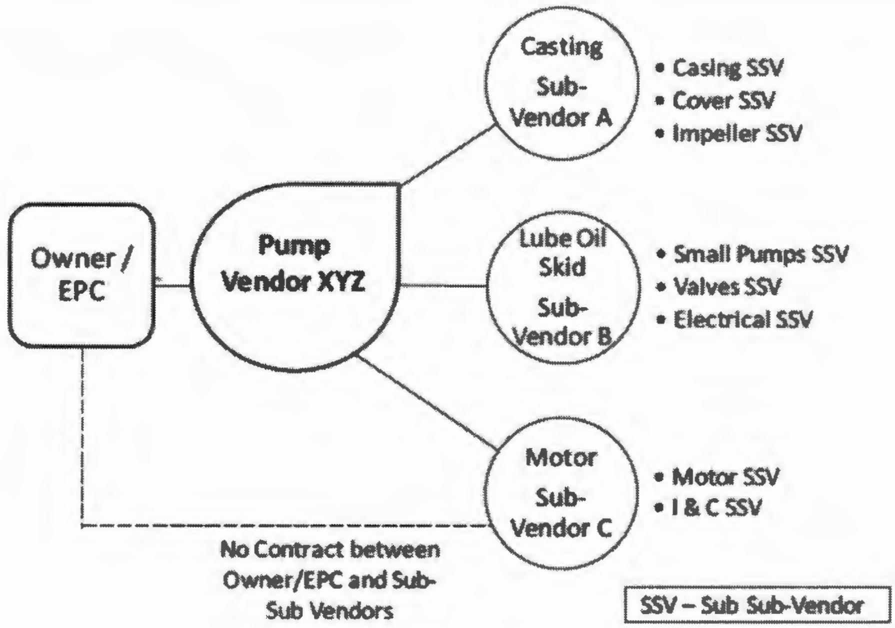
Owner probably pay's for all coordination issues.

Owner pays for any work management issues significant likelihood of extras if scope definition is weak.

Oils Sands Contracts

Given the issue noted in Jergease's findings unit rate contracts seem to be the next logical step in helping the oil sands achieve cost certainty. The elements that were found in Elliot call for the list of standard productivity rates will help the industry focus on implementing an unit rate strategy. The findings of Jergas in his report to Alberta Finance and enterprises is that one of the major challenges facing Alberta is the loss of productivity (Jergeas D. G., 2009). One of the best benefits of the unit rate contracts is that the risk of productivity is part of the execution risk that the contractor is responsible for. His research has shown the technology and engineering intensive scope of complex industrial projects show often times require a large amount of change throughout a project. Breaking a project down to manageable units of measure allow this change to occur without the significant cost that could be incurred with a lump sum project. The ever changing technology combined with the complex procurement scheduled associated with the oil sands mean that having a complete scope of work and specification throughout the course of construction means that the lump sum project while possible will be very difficult to achieve at a fixed cost. Jergeas best demonstrates the issue of why vendor data take so long to get to the engineer to be included in a scope with infographic below

Figure 13 Vendor Flow Diagram



(Jergeas & Halari, Lessons Learned from the Execution of Oil Sands' SAGD Projects, 2012)

The motor data, lube oil and impeller casting data and specifications are required for the engineer to makes design decisions regarding the electrical and mechanical design for projects. From a project perspective they know there will be a 10 horse power (hp) pump installed. The contractor will know what it takes to install a 10 hp pump. The issue is that depending on the final electrical design the pump may need to have special electrical connections. The pump example demonstrates why lump sum pricing will not be an option in the oil sands. If the pump would have been bid a lump sum the contractor with the complete electrical schedule would be able to claim that there was a change. On a lump sum project the contractor would claim yes they knew about the pump but that the plan to install the pump may have only an electrician for 1 hour to install it. With the new cable schedule it will take at least 3 hours. The contractor will then claim that the new cable schedule has affected the execution plan and cause them to be delayed. The contractor will then file a delay claim. If the contract had been done under a unit rate method the contract would just add or delete the increased installed quantity of cable to the overall quantity and extended it by the unit rate.

Implementing Unit rate contracts as a contract execution strategy can be seen as promoting effective risk management, promoting best practices, optimizing value through the supply chain.

In order to implement unit rate execution plan the goals need to be established. The goals that have been used are:

Streamline field supervision

Streamlining the supervision was achieved through setting up standard crew sizes. The group would question when the crew size would be smaller than expected. The goal was to push the contractor to have as an efficient structure as possible with the lowest possible indirect structure to keep the productivity high.

Reduce cost

To reduce cost that focuses on eliminating overtime. They also focused on only executing scope that was well planned. This eliminates the cost of rework.

Identify and solve barriers

The group worked together to identify any issue that was stopping the contractors from achieving the unit rate. The items they worked on specifically were quality delays and permit delays.

Constantly improve contractor productivity by field measures

The owner would continually push the performance factor down as the contractor became more and more efficient at execution. This is in line with the recommendation from EC Harris.

Provide a fixed cost structure for predetermined work scope

The group works to execute as much scope as possible under the unit rate conditions. This meant that a lot of the scope had to be preplanned and defined to ensure the contractor was not delayed in execution.

In order to meet the objectives, the experience the group in Exxon found that it was necessarily to clearly communicate at the outset of the projects what the responsibility of each function was. (Parra Diaz, 2008)

Contract Management

The responsibility of contract management is to assure that the scope is being executed in a way that is compliant to the contract. The concerns that are relevant to the oil sands owners are health and safety and environmental management as well as quality compliance. The second responsibility of the contract management function is to look for ways to improve the contract. An example would be benchmarking the contracts and working with procurement to determine the most effective rates. Many of the benchmarking tools and management theory has its roots in the continuous improvement models of Lean and Six Sigma that has been successfully implemented in the manufacturing industry in the late 1970's and early 1980's. Much of the theory deals with having in-depth performance and reporting metrics.

Reporting

The function of reporting is to give the end users of the contract the tools to help decision making. It is important to establish what the mandatory contractually bound reports are. There needs to be a report that captures and monitors the savings generated by the unit rate contract. The reporting needs to be well understood by both parties. Often with unit rates there are rules of credit that are established to capture the scope and track the progress on a earned value basis. An example of the rule of credit is if a footing is being built and has a concrete volume of 4 cubic metres, the contractor may earn half of the value by just completing the form work. There needs to be a clear understanding on how the rules are established and that they truly reflect the scope that is being executed. The goal of the reporting is to provide meaningful information that can easily be calculated and audited by both parties. There needs to be a focus on quantitative reporting. The most important measure will be the overall productivity factor (PF). Commonly in the industry this is known as PF factor and is based on a scale of 1 being the scope executed at the average rate. A PF factor is the measure of efficiency

Invoicing Process

The function of the invoicing process is to resolve issues with the contractor invoicing process. Often when a unit rate is being used as a contract type there may be many rates given the circumstances of the work be it easy, medium, or hard. The unit that is used will need to be verified and attested by the contractor and owner. The complexity associated with unit rate means that often the accounting staff will have to have the direct operational involvement in order to ensure that the invoicing is capturing as much of the scope as possible. There also needs to be clear instructions on how to deal with invoice disputes. The issue of not capturing all of the invoicing at the correct unit rates was experienced in the study of the sport field house in Bucharest (Nazilli & Postavaru, 2012) The inexperience on the contractor side resulted in the contractor not billing the higher labour rate for more difficult concrete work

Unit Rate Management

The function of unit rate management is to collect data for future contracts to start the sliding scale of improvement. As a contractor becomes more efficient in the execution of scope, the site difficulty factor is reduced. The owner needs to monitor the contractor's progress to amend the rates in future negotiations. The owner also needs to work with the contractor to try and maximize the unit rate utilization in the scope of work. The sliding scale of unit rate is widely discussed in the EC Harris guide to activity rates (EC Harris LLP, 2012)

Efficiency Improvements

The function of the efficiency improvements is to monitor and maximize the efficiency of the spend through initiatives such as overhead reduction or process improvements that yield an improvement in the unit rate. The tracking of the efficiency is critically important to monitor the success of the unit rate implementation. It is also important to actually cost the associated works with monitoring the quantities as they need to be clearly offset from any potential savings.

Rentals Management

The function of rentals management is to coordinate the utilization for rental materials. This is particularly of note when dealing with scaffolding materials. It is important for the scope of all the trades to be considered when erecting scaffolds. While the scaffolds may be over built for some scopes such as pipe installation other trades such as insulation may need more extensive access. Uncoordinated builds can lead to building two scaffolds when one scaffold could have been built to cover both scopes.

The implementation of unit rates requires a cohesive action plan. The experience at the Exxon plant resulted in the following generic findings and focal areas:

Constant communication amongst all sectors of the project. The groups including the contracts, execution and finance group. Communicate results to all people involved in the process on a regular basis. Communication was often in the form of quantitative reports and the review of the reports.

Provide the contractor all the necessary tools to comply with the Exxon Mobil unit rate requirements. This means having clearly defined scopes of work and well developed operational, quality, and safety plans.

Survey jobs to track productivity norms and benchmark collected data. It is important to note the different rules of credit associated with each quantity

Develop rates in conjunction with contractor when applicable.

Provide a tracking mechanism for all the systems that are behind the unit rate utilizations percentage.

Provide training to people involved in the process to clarify expectations and benefits.

Parra also noted that the success of the unit rate implementation was driven by following a very structured task approach. The task was broken down to daily, weekly, and monthly and was performed by the owners group to ensure the objectives were met. The experience of Parra is in line with the work plans that were described by Jergas in his previous works

Daily Tasks

The daily tasks consisted of working directly with the contractors and planners to look for opportunities to execute unit rate scope. The owner group would also spend a significant amount of time in the field to survey the weekly quantities. The main goal being that the unit rate data bases and survey log were up to date. The group would also communicate any challenges or good practices from either the field or office. Included in the communication would be reviews and discussion of the contractor requests for information.

Weekly Task

The weekly tasks would be reviewing the unit rate key performance indicators. The review of the key performance indicators(KPI) is the leading indicator of how the contractor is performing. The group would also perform weekly workshops to discuss findings and what could be done to target compliance to the unit rates.

Monthly

The monthly tasks were to complete the unit rate utilization for the report to compare how much scope was being completed at the unit rate and how much was being completed on a time and materials basis. The group would then discuss the root cause of both negative and positive results. The owner and contractor group would then prepare for a monthly stewardship report and meeting. The intent of the stewardship report and meeting is to engage the senior members of both the owner group and the contactor to work through the strategic issue and guide the contractor to the a goal of having all scope complete under a unit rate contact.

Overall the implementation of the unit rates at the Exxon Mobil facility found that as the supplier was drawn into driving productivity in order to improve their overall profitability the benefits accrued to the owner at the same time through cost certainty. (Parra Diaz, 2008) The cost saving experienced at the Exxon Mobil refinery ranged between 15% and 27% as compared to cost plus spends.

Parra did note that the owner reduces risk but that there is a lot of work to agree to with the contractor. The owner and contractor need to develop schedules of rates that consider the different conditions that may be experienced but most importantly they need to come up with a plan to deal with situations where cost plus rates should apply.

Also of significant note is the requirement for constant measuring of executed quantities and project cost control. Although Parra noted the quantity reconciliation several times it is clear from the experience of Nazilli that even in simple civil institutional scopes there can be significant issues with quantity reconciliation (Nazilli & Postavaru, 2012) the scope of the quantity reconciliation is often performed by professional quantity surveyor or cost engineers. The positions are both in high demand in North America. The quantity survey trade has a long history in European construction where labour cost is much greater. One of the issues of getting the value of unit rates contracts implemented in North American on a grand scale is the amount of work required in setting up the data bases for the cost engineers to work with. This issue was discussed by Eliot in is 2005 paper.

Schedule of Norms

One of the items touched on by Parra is the discussion of eventually tightening the rate up. The concept behind decreasing the man hours is based on the learning effect the contactor and owner will experience as they become more familiar with the scope of work. (Parra Diaz, 2008) In the construction industry the amount of time it takes to complete a task is well known. The rates have many different names and may be known as schedule of Norms or Work Activity Rates. The rates are reported worldwide, with the most common bases in the global oil and gas industry being the rates published by the Dutch Association of Cost Engineers. The D.A.C.E. rates are known are used by global petroleum players such as Royal Dutch Shell, Statoil, and Total. The rates are developed using the best practices of what it takes to install a lineal foot or pipe or a tonne of steel under ideal conditions using the average western European labour.

Figure 14 Man Power Calculation

Example: Install 100ft of prefabricated 6"nb Sch 40 Carbon Steel Pipework, incl. 1 no. Valve and 12 no. 150# Flanged joints

	Quantity Unit	WAN	Hrs
Erect Pipe	100ft	0.24	24.00
Install valve	1 Nr	0.81	0.81
Making flange joint	12 Nr	0.42	5.04
Pressure test insitu onsite	100ft	0.061	6.10
			35.95 Hrs

In this example, the time required to complete the task in 'ideal' conditions is almost 36 hours in total. This could equate to 3 men x 12Hrs = 36Hrs.

(EC Harris LLP, 2012)

The issue is that many engineering firms have is determining how to factor the schedule of productivity for the enviro6nment of Northern Alberta using Western European productivity as a model. The difficulty is not only the differences in contractors but the level of skill of the craft, the safety requirements, the quality requirements, and environmental climate.

Figure 15 Bases of WAN

(EC Harris LLP, 2012)

Once a labour rate is determined, they need to be factored. The factors vary from site to site and also vary from contractor to contractor. The challenge is that that although at first glance the labour rate is negotiated with multiple contractors may be different. A contractor's price could be less expensive than another contractor's price. The issue is that once the contact factor is applies the higher labour rate may make more sense Below is an example of the comparison of a hypothetical contract factor analysis.

Figure 16 WAN and Site Factor

	Base WAN Hrs	Contract Factor	Estimated Job Hrs
Contractor 1 - Site A	35.95	1 8	64 7
Contractor 1 - Site B	35.95	1 5	53 9
Contractor 1 - Site C	35.95	2.1	75.5
Contractor 2 - Site A	35.95	2 0	71.9
Contractor 2 - Site B	35 95	1 8	64 7
Contractor 2 - Site C	35 95	2 4	86 3

(EC Harris LLP, 2012)

The next challenge faced is how to generate contract factors and under what conditions to apply them. One of the common industry practices is to have the contractors submit a schedule of hourly rates to the owner listing how long it would take to perform a task at their site. The owner can then bench mark the contractor's submission against their own internal productivity data. Once the contract factor is determined there are other conditions to be considered. The conditions that need to be considered can include weather condition. The effect of weather is profound. As mentioned earlier it needs to be determined if the work is going to be executed at heights or could the work area be congested because of the issue with other trades being in the area. All of the possible condition factors can be determined and rated. The challenge is having the staff knowledgeable enough with the scope to know when and how to apply the factors and how to have the owner agree to the factors so that invoicing proceeds quickly and is fair to both parties.

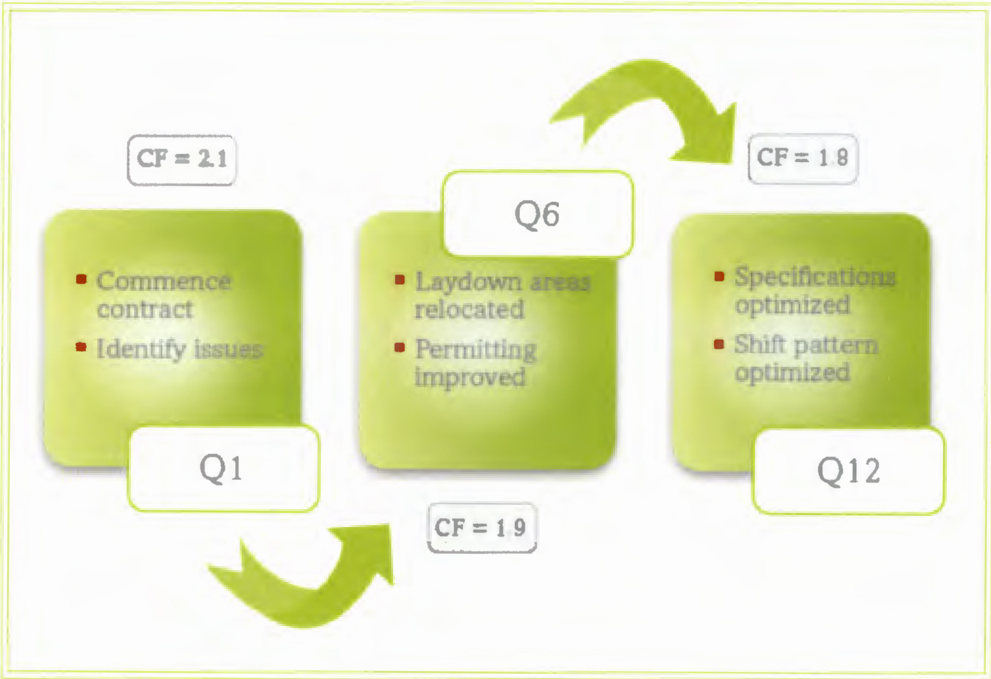
The benefits of having a contract that uses fully developed schedules of norms is that over time the factors on both the contract and conditional factor can be improved upon. The transparency of the contactor cost as well as the transparency of the owners or outsides forces on the work show how individual events or constraints effect the project. By using the schedule of norms all of these issues can be monetized in a calm and non-adversarial way.

The second benefit of having the developed rate is the risk is allocated to the party who can control it. The development of the rates and execution using the rates mitigates the volume based mentality that is inherent with time and material contracts.

Overall the development of the rates allows the owner to bench mark the performance of contractors in a meaningful way that helps identify improvement opportunities that benefit both the owner and the contractors. The win- win benefit can help facilitate a culture of continuous improvement that is focused in improvements in efficiency and productive. It also enables the possibility to focus on issue such as implanting automated processes such as permit issuing or identifying issues such as inspection delays.

The process requires multiple years to have the full effect but given that many of the projects in the oil sands are done in multiple phases lasting 3-5 years per phase it will allow the efficiencies that have been experienced in the maintenance scope of petro chemical be experienced in new construction. Below is an example of a hypothetical contract factor improvement over a 3 year period.

Figure 17 Contract Factor Sliding Scale



(EC Harris LLP, 2012)

Good Faith

One of the consistent themes through all of the research surrounding the construction contract is the issue of how to deal with change in a non-negative manner. The concept has been researched extensively in the legal community. Dagenais states that the classical view of construction contract as an adversarial process in which the owner wants the highest quality product at the lowest price while the contractor wants to spend as little time as possible and maximize their profits. The traditional model may generate conflict more particularly if there are issues where parties come from different back grounds and jurisdiction (Dagenais, 2007). Dagenais view is in line with the perspective that was offered by Eliot and Jergas work on the cost over runs in the oil sands.

Dagenais argues that if we advocate good faith as a key element of the contract we can change the nature of the contract to a more partnership focus frame work rather than an adversarial based one. Dagenais states that in Canada the good faith element is written into the professional rules of professions involved in the construction industry. This is particularly true for professional engineers. The legal requirement to act in good faith is changing the nature of the industry and is resulting in what Dagenais calls the "new contract morality"

The new contract morality is underpinned by two main elements that are the basis of the communication of information. The elements are the duty to inform and the duty to counsel. In construction as the duty to inform is not a pure act of willing. It occurs when a situation present the three following aspect:

1. Someone knows something or is required to know something.
2. The knowledge of the information would assist the partner.
3. The partner legitimately trusts the first person to inform them.

Dagenai has found that some research has indicated that setting up an information management system may be an effective ways of accomplishing the duty to inform. The information management system needs to be jointly owned by both parties and not for the sole use of one party. Often in construction projects the document control system is for the sole benefit of the engineering firm and the contactors can only access information that has been issued to them. The argument of Degias is the system should serve as a means to facilitate the rapid provision, manipulation, and assembly of specification for all those concerned in the construction process.

The Duty to Inform

The duty to inform goes far beyond just having the documents available for review. Dagenai believe the building team, should inform they trust them with regards to receiving all the information as soon as possible. A client is entitled to expect that the information the builder has provider regarding skills, capacity, and schedule to be accurate. With both of those foundations laid the expectation is the groups will openly communicate what their real capacity to complete the project on time is. This is practicality true when we consider Jergas work on why projects fail with the lack of communication that the early engineering milestones are not being met. Good faith means that the relevant facts be brought to the attention of the parties throughout the course of the contract and not just at specific milestones.

Duty to Counsel

The duty to counsel is related to the status of professionals as they not only have a duty to inform but a duty to use their specific expertise. Dagenai states that the duty to counsel consists of issuing an opinion, conclusion, or analysis drawn from the facts.

"The contract language that can be used to introduce the concept of good faith may include language like "The parties shall keep each other informed regarding circumstances which may be considered of significance to the Total Work. If a party does not fulfil his obligation to notify as aforesaid, he shall be liable for the loss caused."

The use of good faith in contracts is very important in setting the grounds for dispute resolution. With any construction project despite the best intention of the parties there may be at some point a dispute. Deagains argues the most effective method for working through disputes is to have an independent non-binding panel of experts that are familiar with the project to help mediate of constructively. This can mitigate the negative a sentiment to the dispute. The argument is that a good faith plays an important role in the exchange of information and in the resolution of disputed. The end result is a partnership that is founded on collaboration rather than confrontations. The partnership allowed parties to work together from the very beginning of the project. The essential factors of partnering include mutual objects, problem resolution, and continuous improvement. It is important to note that the finding of Degainas is almost matching the findings of Paars in the unit rate implementation plan at Exxon.

Unit Rate Simulation

Unit rate contract have gained a following in the Alberta construction community but there has been much debate as to whether under the current market condition if the contractor and owners are ready for the implementation. The selection of the contactor is one of the most important choices in determining the success of a project. Currently there are various methods used and despite the warning of groups like EC Harris and the D.A.C.E it is often the lowest price that is taken. There are calls for a complete and methodical bid evaluation to complete but it is often not complete and the owners select the contract without knowing the full effect of productivity m delay and quality. (Nutakor, 2007)

Nutakor has done an empirical study of the weight and imarts that have been associated with cost overruns in projects in Northern Alberta. The results of the study found that similar to Jergas work primary factors in determining an over run were

Change order

Level of scope definition

Bid Process

Contract Risk

Market conditions

Risk Management

Performance issues

The seven factors account for the difference between the bid price and the estimate base on the unit rate and the final cost of the project under the different project conditions. Nutakor did a Monte Carlo simulation and found that the lump sum model resulted in the largest price increase as the changes were mostly contested by the contractor. His simulations also found that the project was also negatively impacted by unit rate contracts.

Figure 18 Monte Carlo Results

Statistic	Stip. Price Contract Value	Unit Price Contract Value
Minimum	52.75	50.93
Maximum	256.64	228.13
Mean	151.01	132.91
Standard Deviation	35.10	30.79
Coefficient of Variation	23.25 Percent	23.17 Percent
Percentile	**Value**	**Value**
5th	98.05	86.16
10th	107.80	95.87
20th	120.01	106.45
30th	130.05	114.99
40th	140.87	123.50
50th (Median)	148.54	130.50
60th	157.59	137.89
70th	168.13	147.95
80th	181.37	158.78
90th	198.05	175.67
95th	212.98	187.30

(Nutakor, 2007)

The results that were presented were based upon a Monte Carlo simulation using all the known data results possible. The results show that there is a definite advantage to using unite rates over lump sum contracts but that the contracts still carry more overrun risk that the cost plus methodologies

Nutakor findings and recommendations is that despite all of the work of the owner groups to make awareness of the issue of total cost of ownership in a contracts that lump sum and unit rate contracts should be avoided because the contractors are aware the incomplete bid analyse are being complete and it is most likely the owner will go with the lowest price in the end. With that being said Nutakor recommends that contractor at risk contracts be avoided as the contractors will just submit low prices and make up the extra fees and profits on the changes and extras

Conclusions

The recommendations for the construction industry at this juncture are to investigate the use of unit rate but to be very cautious.

The significant changes in the demographics in the Regional Municipality of Wood Buffalo seem to indicate that the availably of trades people in the local area should be sufficient for the continued growth and ongoing maintenance of the plants without experiencing the same labour availability issues as in the past. The above provincial average attainment in post-secondary education is the strongest indicator that the municipally is in a strong position to see a spontaneous generation of labour productivity.

The lessons learned by the construction industry in Alberta are a clear indicator that things in terms of labour productivity need to change or the investment in new projects will cease to continue. The challenge will be for the industry to commit to the rigors and discipline required to see the cost savings that can be generated by unit rate contracts. It will be difficult for the owners to convince the shareholders of the significant overhead and resources cost that will be required to commit to the unit rate mentality. The greatest recommendation is for the owner to start implementing the unit rate contracts on a very small scale to start with, much like Paara experienced in the Exxon case. The additional administrative cost that are associated with the execution of unit rate contracts are almost eclipsed by the massive savings almost immediately.

The difficulty in implementing unit rates at the outset is going the be the issue that Naakaor identified in his work with the contractors submitting rates that are artificially low knowing that most of the scope will be executed on a cost plus basis for the majority of the project and that given the recommendations of groups like EC Harris the first execution of the rates may be very lucrative and easily achievable. The combination of the two factors of the contractor submitting lower rates with high contract allowance factors will mean that the scope being executed under unit rate will be very expensive and may cost more than the time and materials method. Then to add on the majority of the scope will still be executed at the unit rate will mean that there will not be much corporate will to push to the new model.

The strength in implanting unit rates will come with the savings that continue to be seen in the maintenance industry. The experience or Paaar shows that the savings can be significant. The saving grace of the unit rates will be the continued research of groups like EC Harris and Bruce Elliot who can prove using stochastic models what are the tangible and quantifiable results.

The overall conduction of the research is that unit rates will be a valuable addition to the construction industry but unfortunately the development of the data sets and the expertise to implements the data and contracts does not yet exist in Northern Alberta. There needs to be further work on estimating what the cost of having the owner and contractor groups develop the expertise to execute unit rate scope and provide professional feedback when there are issues executing the scope under the conditions.

There is also the legal ethical consideration of how to incorporate the concept of good faith into the contract. Given the current legal conditions and the perceived litigious nature of the clients in Fort McMurray having a contract that specifies damages for acting outside of the intent of good faith may result in the contractor including a risk premium in their pricing to cover any potential legal cost. The legal concept of good faith and duty to counsel may have issues with the situation that Jergas presented in which there may be sub-vendors that may not have the same contract language as the prime contractor. Often with the smaller suppliers the terms and conditions are very limited and may not cover all of the intended goals of the prime contact.

The recommendation that can be provided at this juncture is to work on developing unit rate scope for the trades that have the least amount of variability in them. Using the EC Harris guide I believe that the scope of support trades such as insulation and scaffolding would benefit the most from unit rate contracts. The changes in engineering do not affect the scaffold or insulation trades as much as the mechanical and electrical trades. There also need to be an established and accredited schooling program to ensure that the owner and contractors have qualified field staff. Given that the issues with productivity are affecting the Canadian economy it is recommended that the Alberta and Federal governments work to establish programs for training quantity surveyors on a large scale as soon as possible

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