RELATIONSHIP OF PROJECT CONTEXTUAL SETTINGS AND EXECUTION

best practices with schedule growth on major construction projects

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Abstract: This research analyzes data of major construction projects from the oil and gas industry executed in Alberta, Canada and USA (from 2019 to 2015) to identify the relationship of project contextual settings and execution best practices with schedule growth. The researcher found that project's contextual settings like; project type, execution strategy, project nature, delivery method and place of execution can lead to schedule growth. Also, execution best practices, such as; timely delivery and accuracy of engineering deliverables, modularization, communication, working relationship, project team's expertise, core project team turnover, constructability, construction productivity and risk management were found correlated with the scheduled growth. The researcher concludes that organizations should adopt execution best practices and mitigate the impact of contextual project settings to avoid schedule growth.

Keywords: Risk, Schedule, Major Projects

1. INTRODUCTION AND BACKGROUND

Canada is the fourth-largest producer of oil and gas in the world. During 2018 Canadian oil and gas contributed $160 billion (7.7%) to Canada's gross domestic product (GDP) with a capital expenditure of $52 billion and created over 576,000 jobs. Canadian oil and gas industry contributed a total of $119 billion (1/5th of the total exports) during 2018 into Canadian exports [1]. "Alberta has proven oil sands reserves of 167.9 billion barrels. Alberta ranks third, after Venezuela and Saudi Arabia, in terms of proven global crude oil reserves" [2]. Oil and gas industry has been a central part of Alberta's economy for the past few decades and has played a vital role in the Canadian economy.

Major projects are essential for oil and gas organizations to achieve their corporate objectives, continue necessary growth, maintain their operations to remain profitable and remain competitive within industry. Projects are executed within the boundaries of a defined scope, time, cost and quality to deliver the project objectives or outcomes. According to the Association of Project Management (APM) [3] (p. 8); "with projects representing high costs, becoming more complex and increasingly using extended supply chains and multi-geography virtual teams, they also represent high risk". "Construction projects in Alberta are not only mega and complex but they have unique characteristics and it is not uncommon for these projects to experience cost overruns up to 100% of the original cost estimate and limited schedule overruns" [4] (p. 2). According to Construction Owners Association of Alberta (COAA) [5] (p. v); "The average cost growth for Alberta projects was 19% and average schedule growth was 17%". In a recent study; Haines et al. [6], found that Alberta projects experienced much higher cost growth as compared to the project executed in the United States.
According to COAA [7] (p. 47); "Given the anticipated number of planned projects in Alberta over the next number of years and high expectations from project sponsors, the proper estimation and control of project cost and schedule remains paramount". Recent lower oil prices in the international market and reduced oil demand have placed producers in a very challenging situation. Oil and gas organizations are focusing on becoming more efficient, by reducing the overall cost of oil production, by finding ways to improve their project execution practices to avoid schedule growth and cost overruns and increase project predictability.

Projects are executed in the context of a global environment; factors present in the environment have either positive or negative effects on projects. These contextual factors could be on global, regional, organizational or project execution levels. In order to evaluate the impact of contextual settings on schedule growth, the following project contextual factors were compared to understand their relationship and impact on project schedule growth;

- Same or different design teams for Front End Planning (FEP) and detailed engineering
- Project type
- Project nature (Greenfield vs. Brownfield)
- Project delivery method
- Country of execution (Alberta, Canada Vs US)

Apart from the above mentioned project global and contextual settings, project execution best practices during project execution are also important, and understanding their relationship with schedule growth can help project owners to identify and mitigate their impact on schedule growth. The following execution best practices were selected and were analyzed to find their statistical relationship with the schedule growth by using Pearson's correlation:

- Cost growth
- Timely delivery of engineering deliverables
- Accuracy of engineering deliverables
- Modularization range
- Communication
- Working relationship
- Project team expertise
- Core project team turnover

- Constructability plan integrated
- Constructability plan success
- Construction productivity
- Risk assessment and mitigation planning

The researcher attempted to identify the relationship of the above mentioned best practices with project schedule growth by using statistical correlation and comparison methods.

The objective of this research is to analyze and evaluate Construction Industry Institute (CII) and COAA project data, select and analyze major capital projects focusing on factors leading to schedule growth. The researcher will review the project data to;
• Analyze and summarize findings with respect to; what the original schedules were at the project AFE approval stage and what were the project durations at completion.

- Study and analyze various project contextual settings and execution best practices impacting the schedule and causing schedule growth.
- List key factors that directly impact schedules so that the project owners can identify and address them during project planning and execution phases to control schedule growth.

The focus of this study is to establish the relationship of project contextual settings and execution best practices with schedule growth.

2. Materials and Methods

In order to evaluate the relationship between various project contextual settings and execution best practices and schedule growth in major projects; 127 major oil and gas projects with a capital cost of $200 million and over were selected (Table. 1) form CII)/COAA project data. These projects were executed in Alberta, Canada and United States oil and gas industry within past 20 years. **Table 1** shows total number of projects selected for this research; this number may differ a little for each variable tested based of data availability for each variable tested.

Project Types	Number of Projects	Greenfield	Brownfield	Average Cost
Canada	48	32	16	1,275,290,866
USA	79	45	34	429,468,614
Total	127	77	50	749,149,465

Table 1. Summary of projects Sample data

This research compares projects executed within different global and contextual setting to measure how these factors impact schedule growth. The researcher used mean, median and standard deviation values to reflect the impact and measure the extent of impact in projects within different contextual settings.

To measure the strength of relationship between different project execution best practices and schedule growth, Pearson's correlation coefficient (r) was used. A positive correlation is a relationship between two variables where both the variables move in one direction; if the values of x increases, the value of y will increase as well. While in negative or inverse correlation the two variables move in opposite direction; if the value of x decreases the value of y will increase and vice versa.

The correlation coefficient (r) uses values between +1 and -1 to reflect a positive or negative relationship between two variables. A value of +1 shows a perfect relationship, a value of -1 show a perfect negative relationship and value of 0 indicates no relationship. In this study we used the following values to define positive or negative values of correlation coefficient r;

- High degree: Coefficient value of r between r ± 0.50 and ± 1 indicates a strong correlation.
- Moderate degree: Coefficient value of r between ± 0.30 and ± 0.49 indicates a medium correlation.
- Low degree: Coefficient value of r below ± .29 indicates a low degree of correlation.

Pearson's coefficient is independent of unit of measure of both the values and correlation between values is symmetric; values of x and y or y and x remains same.

3. Discussion

3.1. Comparison of projects with different contextual settings and schedule growth

3.1.1. Same design team for FEP and detailed engineering

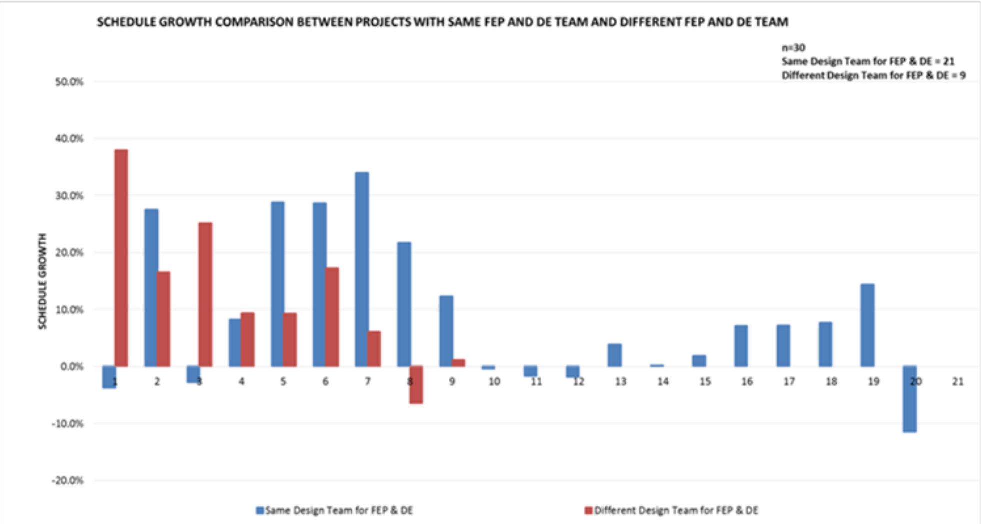
Project owner organizations in general and oil and gas owners of Alberta in particular hire engineering firms to do the conceptual design during scope definition and front end planning (FEP) phase. In some cases project owner organizations hire the same engineering firms to do the detailed design as well, but in some cases, they hire other engineering firms just to do the detailed design. To understand the correlation between using same design team during FEP and detailed design phase or using a different engineering team for FEP and detailed design phase and schedule growth 30 major projects were selected. As described in **table 2**; 21 projects had same design team during FEP and detailed design phase and 9 projects used different engineering teams for FEP and detailed design phase.

The researcher analyzed the impact of using the same design team during FEP and detailed design phase and using different engineering team for FEP and detailed design phase on schedule growth by comparing percent schedule growth in each category. As shown in the **figure 1**; projects that have used same design team during FEP and detailed design had lower percentage of schedule growth (average 8.7% schedule growth), while projects that utilized different engineering teams for FEP and detailed design phase had higher percent of schedule growth (average 12.9% schedule growth). Also teams that used same design team during FEP and detailed design phase had lower mean and median schedule growth scores, their standard deviations were little lower than the teams that used different design teams for FEP and detailed design phase. This indicates that most of the numbers were close to the average in the first group, while the second group had a little higher standard deviation where the numbers were a little more spread out from the average score.

Project Types	Number of Projects (n=30)	Mean	Median	Standard Deviation
Same Design Team for FEP & DE	21	8.7%	7.1%	0.127
Different Design Team for FEP & DE	9	12.9%	9.3%	0.132

Table 2. Summary of the sample data with design team's details

Figure 1. Comparison of Design team details for FEP and detailed design



3.1.2. Project type

All the project data selected for this research study were from oil and gas industry of Alberta and United Sates, however oil and gas organizations do different type of projects for their maintenance, growth and expansion. In order to see if type of project had any impact on schedule growth, this study analyzed 119 projects in four categories, chemical manufacturing, oil refining, oil sands steam-assisted gravity drainage (SAGD) and others. As shown in **table 3**; 37 projects were from chemical manufacturing, 38 from oil refining, 16 from oil sands SAGD and 26 projects were identified as others.

Data analysis found that oil sands SAGD projects had the highest percentage schedule growth scores of mean (12.4%) and median (6.9%) and were second in standard deviation (0.192) after other projects, which means their data numbers are spread a little far from the average. Other projects were second with a mean score of 9.1%, chemical manufacturing and oil refining projects both have a mean score 6.7% schedule growth. This proves that type of project does have impact the schedule growth, **figure 2** illustrates the percent schedule growth and the spread for all the four categories of projects analyzed.

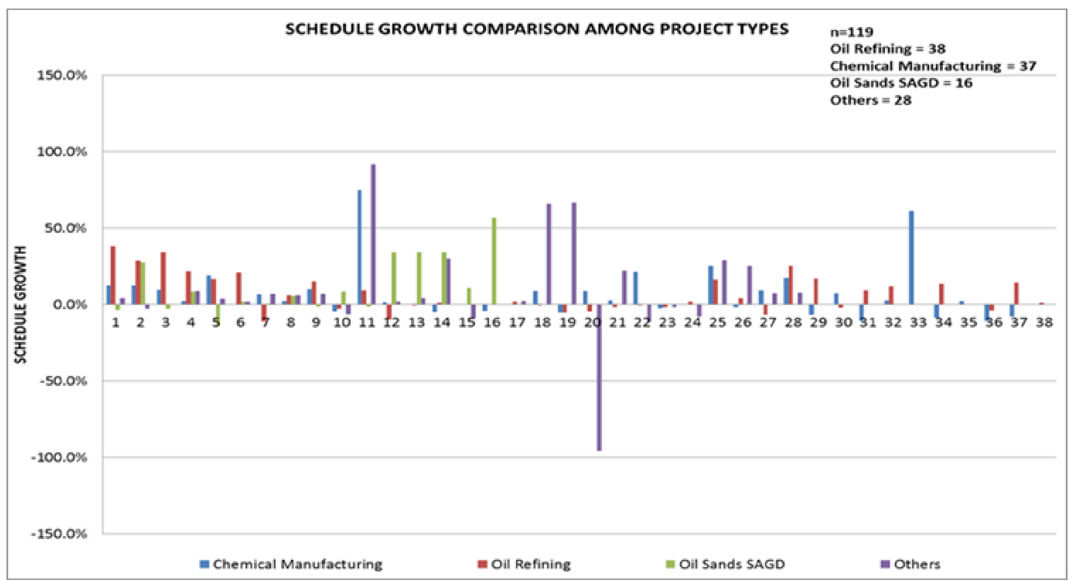
3.1.3. Project nature (Greenfield vs. Brownfield)

In order to understand and analyze the impact of nature of the project on schedule growth, 177 projects were selected; 70 projects were greenfield projects and 47 projects were brownfield, as shown in **table 4**. Both greenfield and brownfield projects have their own advantages and disadvantages in terms of execution. Project organizations require both type of projects and have less control over making a choice between them.

Table 3. Summary of the sample data with project type details

Project Types	Number of Projects (n=119)	Mean	Median	Standard Deviation
Chemical Manufacturing	37	6.7%	2.3%	0.173
Oil Refining	38	6.7%	1.4%	0.121
Oil Sands SAGD	16	12.4%	6.9%	0.192
Others	26	9.1%	-95.0%	0.320

Figure 2. Comparison of project types



Project Types	Number of Projects (n=117)	Mean	Median	Standard Deviation
Brownfield	47	9.9%	3.9%	0.214
Greenfield	70	7.4%	2.2%	0.144

Table 4. Summary of the sample data with project nature details

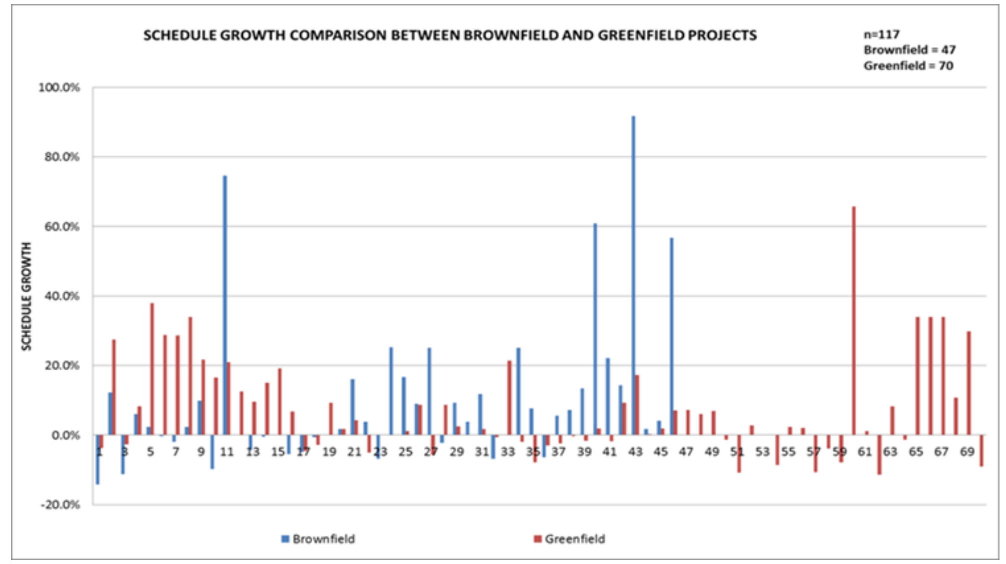


Figure 3. Comparison of Greenfield and Brownfield projects

As shown in **figure 3**; brownfield projects show a higher percentage of schedule growth as compared to greenfield projects. Also brownfield projects had a higher percentage of mean (9.9%) and median (3.9%) scores and higher standard deviation (0.214) as compared to greenfield projects. A higher schedule growth scores prove that brownfield projects are more prone to schedule growth as compared to the greenfield projects.

3.1.4. Project delivery method

Project owner organizations use different types of project execution strategies, these strategies define project delivery methods that these organizations would adopt to execute their projects. There are other internal and external factors that may impact their decisions as well, such as; market conditions and industry norms in certain regions like Alberta. Selecting the right project delivery method is an important decision that project owner organizations take considering the project type, industry environment and available choices of contractors, and most importantly what would be the best fit for the project and project owner. Project delivery methods can have fundamental impacts on project execution as all the delivery methods have their own benefits and risks. In order to understand and analyze the impact of project delivery methods on the schedule growth, 70 projects were selected. As shown in **table 5**; 43 projects were design build or EPC, 13 projects were parallel primes, 6 projects were traditional design-bid-build, 3 projects were construction manager at risk and 5 projects used other delivery methods.

As shown in **figure 4**; CM at risk had highest percentage of schedule growth as compared to the other project delivery methods. Also CM at risk had the highest percentage of mean (47.3%), median (56.7%) and standard deviation (0.497) scores as compared to the other delivery methods followed by parallel prime method, traditional design-bid-build, design build or EPC and others. These results show that project delivery method does impact schedule growth and some project delivery methods have more propensity towards schedule growth than others.

Project Types	Number of Projects (n=70)	Mean	Median	Standard Deviation
Design Build or EPC	43	7.2%	3.9%	0.219
Parallel Primes	13	16.6%	8.3%	0.211
Traditional Design Bid Build	6	7.7%	4.0%	0.113
CM at Risk	3	47.3%	56.7%	0.497
Others	5	3.8%	-2.8%	0.145

Table 5. Summary of the sample data with project delivery method details

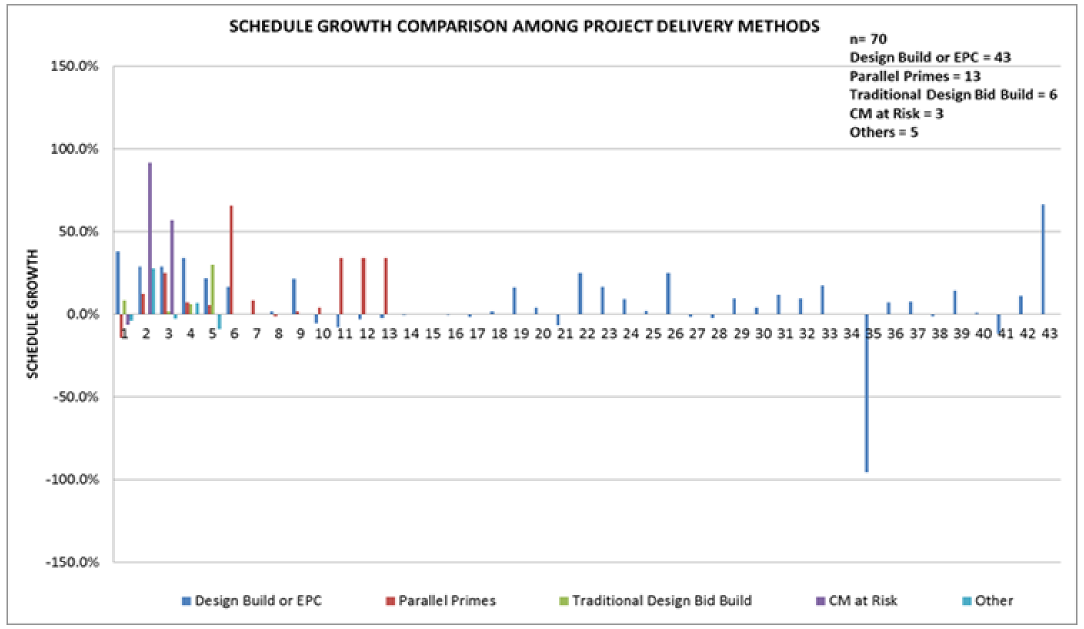


Figure 4. Comparison of project delivery methods

3.1.5. Country of execution (Alberta, Canada vs. USA)

According to COAA report II [8]; generally Alberta projects experience poorer cost and schedule performance as compared to the U.S. projects. In order to analyze the impact of country of execution on schedule growth, 121 projects were selected. As shown in **table 6**; 43 projects were executed in Alberta, Canada and 78 projects were executed in the United States.

The average schedule growth for Alberta projects was at 15.0 % while U.S. projects showed a 5.2 % schedule growth, median valued for Alberta projects was 7.7% and for US projects it was 1.1%. Also standard deviation for Alberta projects was a little higher than US projects which indicates that Alberta project data in more spread form the mean as compared to US projects. **Figure 5** describes a comparison between projects executed in Alberta, Canada and US; we can see a higher schedule growth in Alberta projects, which proves that country of execution does impact the schedule growth.

3.2. Relationship of project execution best practices with schedule growth

3.2.1. Cost

Cost growth and overruns are common in major projects in Alberta and in recent two decade projects have seen enormous cost overruns, as concluded by Dr. Jergeas & Ruwanpura [4] (p. 2) that; "it is not uncommon for these projects to experience cost overruns of up to 100% of the original cost estimates". As shown in **figure 6**; 121 projects with cost variance from the original AFE budgets were analyzed to find the relationship of cost growth with the schedule growth. The result show a moderate positive relationship (r = 0.34524) between cost growth and

Project Types	Number of Projects (n=121)	Mean	Median	Standard Deviation
Alberta, Canada	43	15.0%	7.7%	0.210
USA	78	5.2%	1.1%	0.152

Table 6. Summary of the sample data with country of execution details

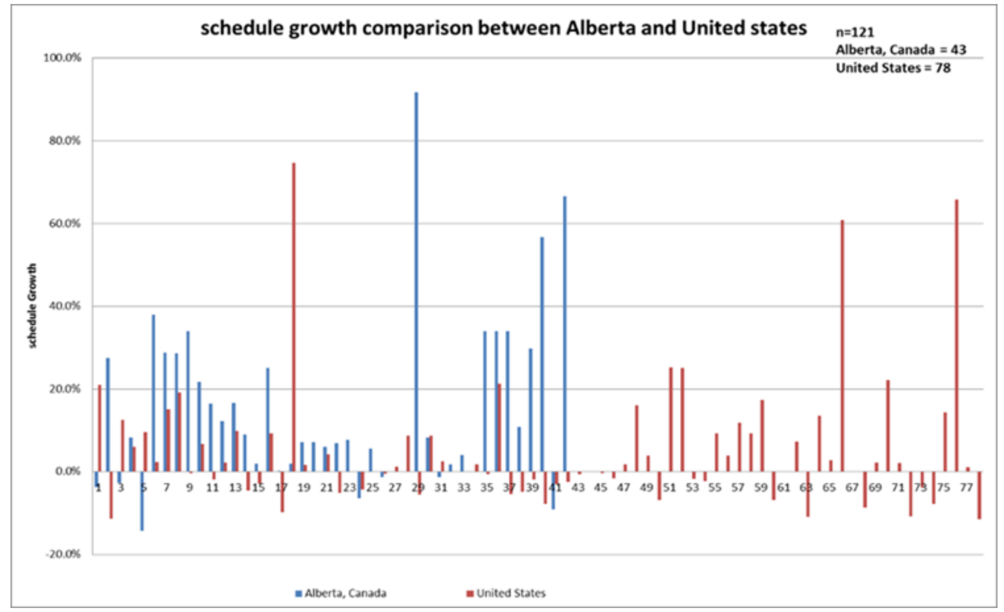


Figure 5. Comparison of project country of execution

schedule growth. This positive correlation between cost growth and schedule growth is evident that cost increase in projects have moderate effect on the schedule increase and similarly schedule growth will have an effect on cost increase as well.

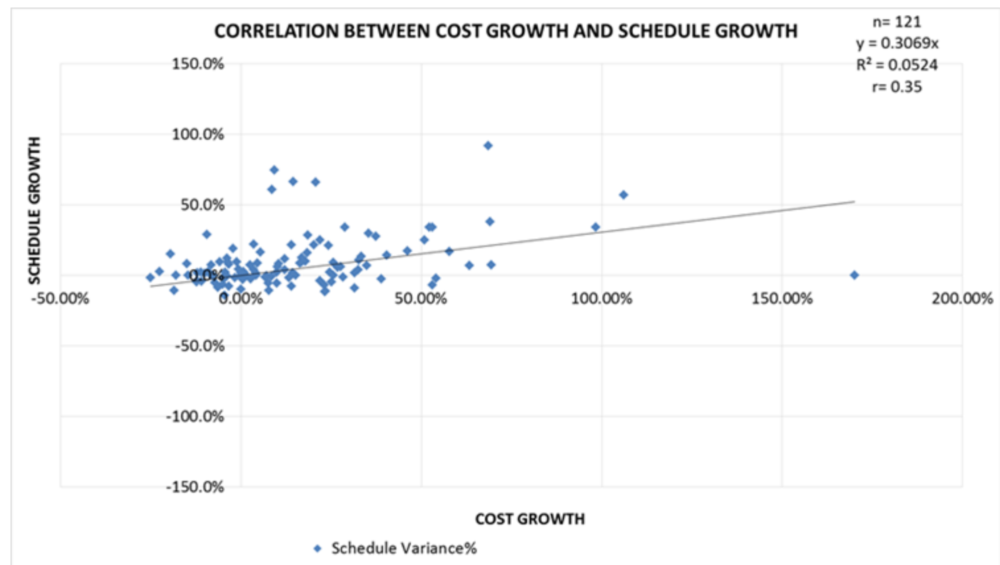


Figure 6. Correlation between cost growth and schedule growth

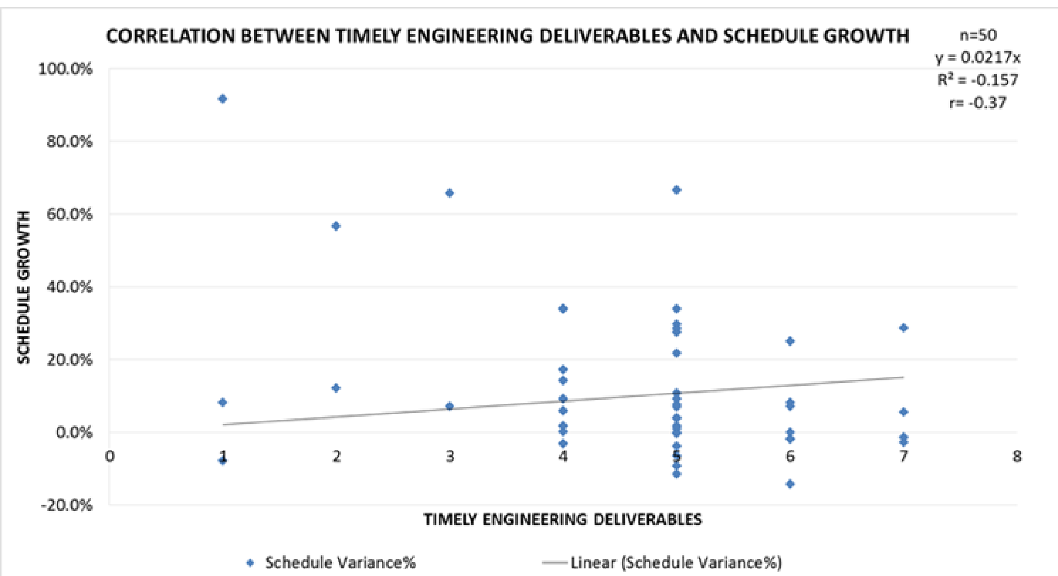
3.2.2. Timely delivery of engineering deliverables

Timely delivery of engineering deliverables is important for many aspects of the project, such as; to continue with the design development, to support other engineering disciplines with their design, to orders the material with correct specifications, to order the right material quantities, to avoid rework, to reduce quality issues during execution, to reduce the number of request of information (RFI) during construction and construction execution as per plans. To evaluate the relationship of timely delivery of engineering deliverables 50 project data was analyzed. As shown in the **figure 7**, the researcher found a moderate degree (r = - 0.37) of negative correlation between the timely delivery of engineering deliverables and schedule growth. This moderate degree of negative correlation validates that timely delivery of engineering deliverables reduces schedule growth, while delays in delivery of engineering deliverables leads to schedule growth.

3.2.3. Accuracy of engineering deliverables

Accuracy of the engineering deliverables is essential for the further scope definition and design development, to support other engineering disciplines continue with their design, to avoided rework, to order the right material quantities and to avoid any engineering changes during the construction execution. Any deficiency in engineering deliverables can cause rework and it can increase cost or schedule or both, which can delay the overall project depending on the level of deficiency and the criticality of the engineering deliverable. To evaluate the relationship between accuracy of the engineering deliverables and schedule growth, 50 project data was analyzed. As shown in the **figure 8**, the researcher found a moderate degree (r = - 0.32) of negative correlation between the accuracy of engineering deliverables and schedule growth. This negative correlation proves that decrease in the accuracy of engineering deliverables moderately increases schedule growth and increase in accuracy of engineering deliverables moderately reduces schedule growth.

Figure 7. Correlation between timely engineering deliverables and schedule growth



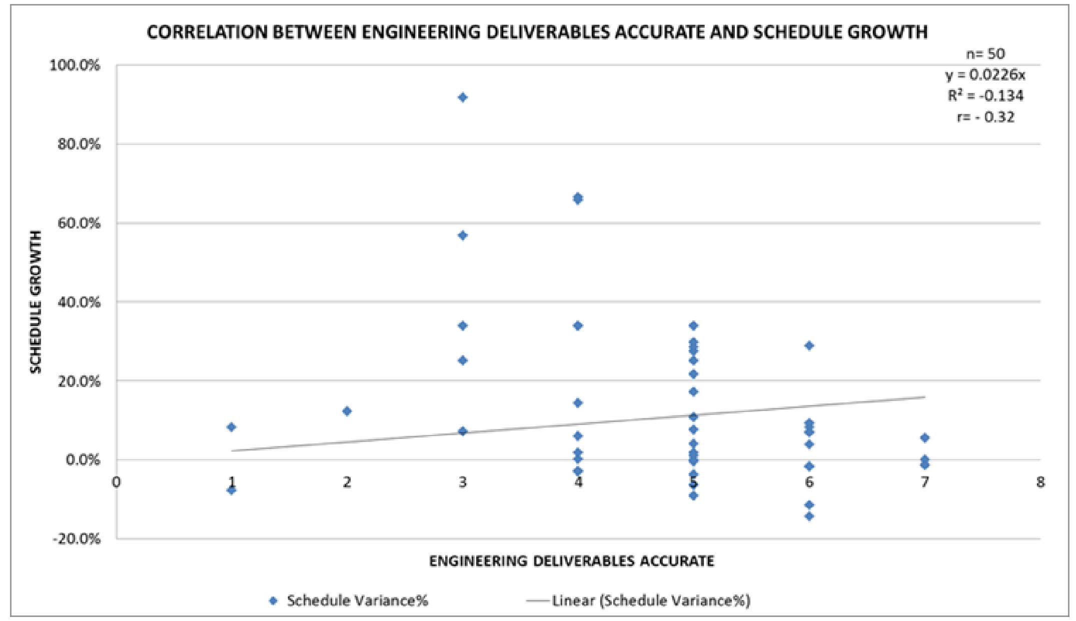


Figure 8. Correlation between engineering deliverables accurate and schedule growth

3.2.4. Modularization range

Most of the oil and gas reserves are in northern Alberta. Due to remote location of these projects, project owner organizations face challenges of finding and keeping skilled labour with high transportations and camp costs to work in remote locations, project execution in hash cold weather, access limitations to the sites, loss of construction productivity and very high cost of project execution. In order to avoid these challenges oil and project owners use modularization for a certain percentage of the projects in big cities in a temperature controlled environment and then transport these modules to sites for installation.

To evaluate the relationship between use of modularization for a certain percentage on projects and schedule growth, 56 project data was analyzed. As shown in the **figure 9**, the researcher found a low degree (r = - 0.17) of negative correlation between the modularization and schedule growth.

This negative correlation between percent modularizations and schedule growth indicates that decrease in percent modularization leads to slight increase in schedule growth and increase in percent modularization leads to a slight decrease in schedule growth.

3.2.5. Communication

Effective project communication is important for the proper flow of information among project team, timely communicate decisions and project reporting. Dr. Jergeas [9] found poor communication among one of the reasons for cost and schedule overruns. To evaluate the correlation between the project team communication and schedule growth, 33 project data was analyzed. As shown in **figure 10**, the researcher found a low degree (r = - 0.19) of negative correlation between the project team communication and schedule growth. This negative correlation is evident that decrease in project team communication contributes to schedule growth, while increase in project team communication can help reduce schedule growth.

3.2.6. Working relationship

Good working relationship plays a vital role in project executions; it builds a cooperative team environment, it helps encourage project team members' interaction, it also helps improve project team communication and coordination, and leads to a positive project team culture. To evaluate the correlation between the project team's working relationship and schedule growth, 29 project data was

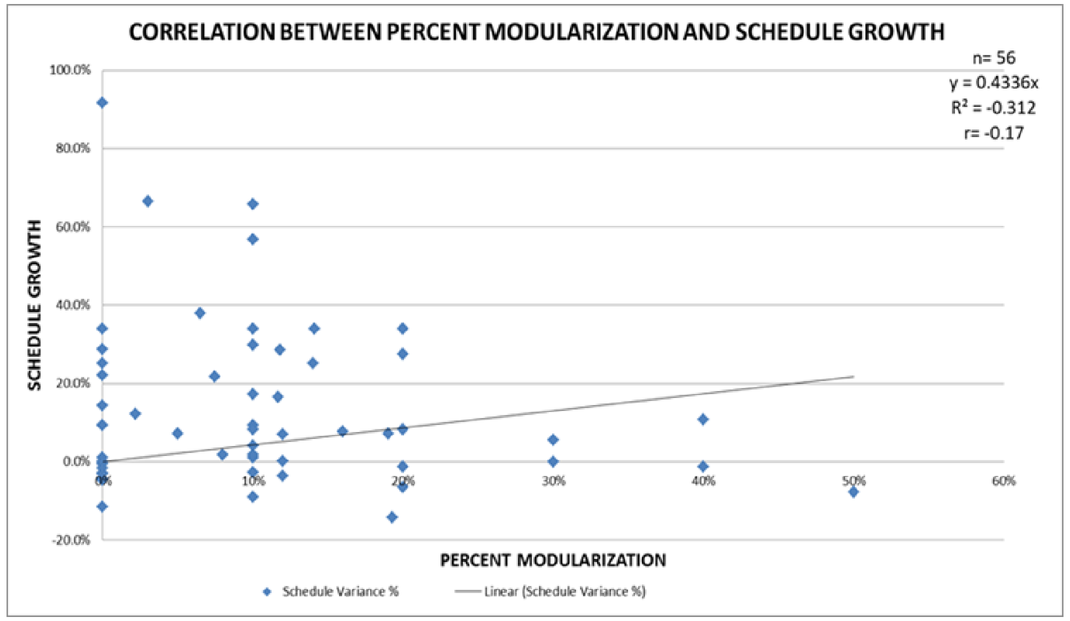


Figure 9. Correlation between percent modularization and schedule growth

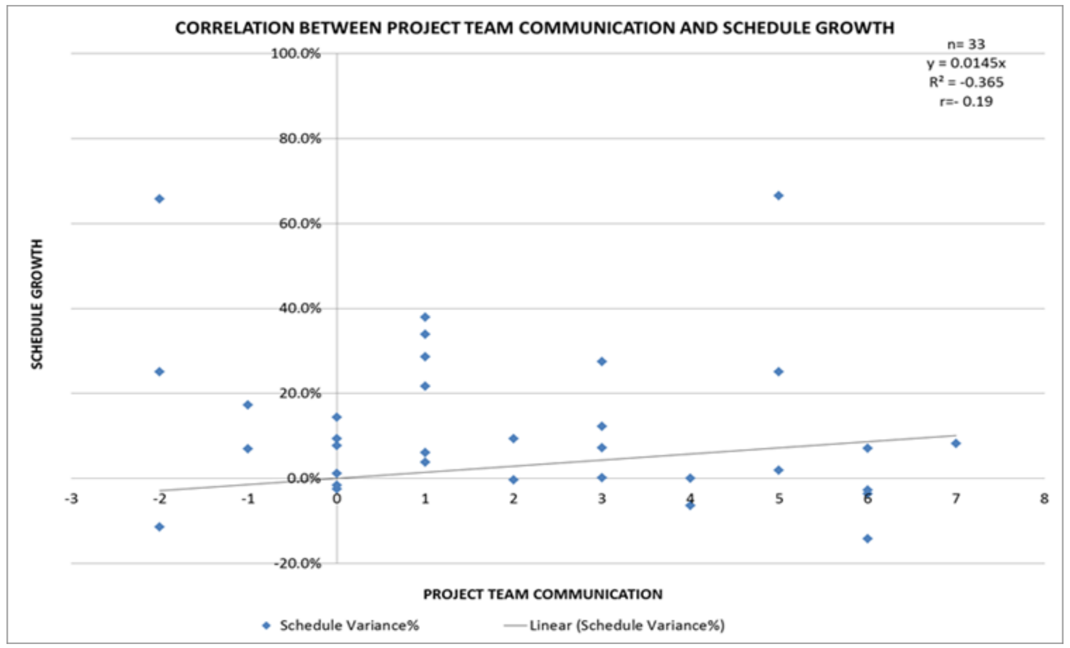


Figure 10. Correlation between project team communication and schedule growth

analyzed. As shown in the **figure 11**, the researcher found a low degree (r = - 0.10) of negative correlation between the project team's working relationship and schedule growth. Which indicates that decrease in project team's working relationship contributes to schedule growth, while increase in project team working relationship decreases schedule growth.

3.2.7. Project team expertise

Projects are executed in a team environment; project team members are selected based on their relevant education, skills and work experience of similar projects. Project team members bring specialized skills and experiences to build a team combination that can execute the project successfully. Highly

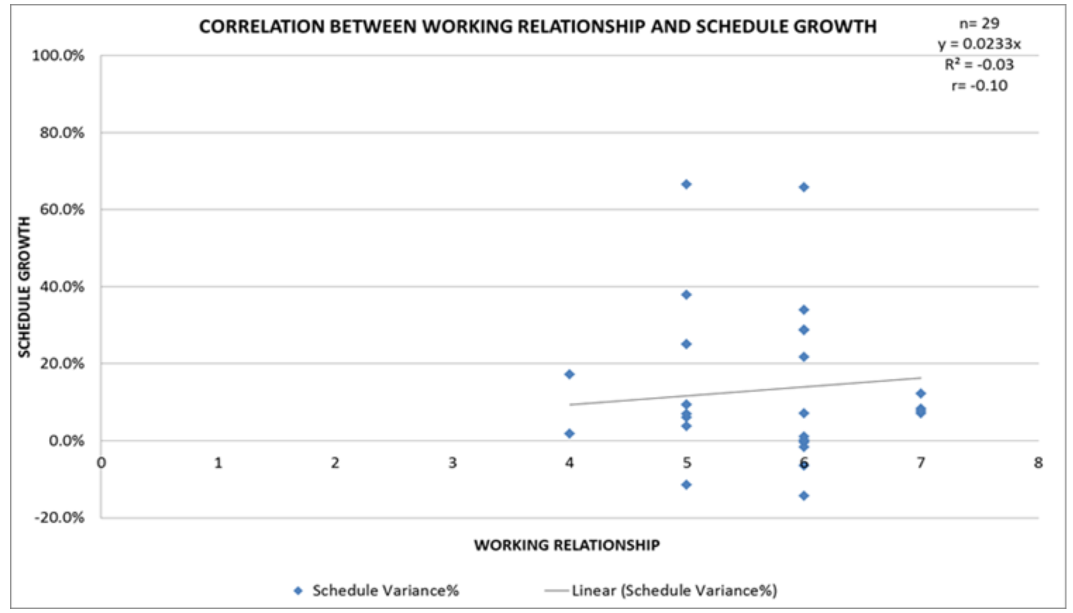
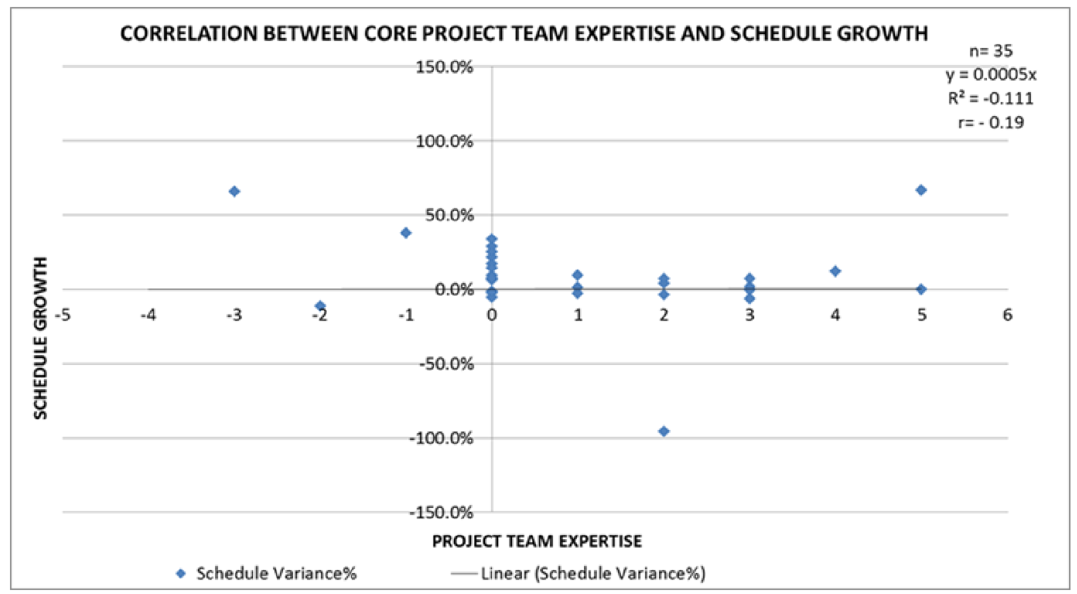


Figure 11. Correlation between project team working relationship and schedule growth

skilled team member's work collectively to build positive teamwork that fosters trust, team members share specialized skill, talents and strength in order execute the projects effectively. To evaluate correlation between the project team's expertise and schedule growth, 35 project data was analyzed. As shown in the **figure 12**, the researcher found a low degree (r = - 0.19) of negative correlation between the project team's expertise and schedule growth. This negative correlation demonstrates that decrease in project team's expertise positively impact schedule growth, while increase in project team expertise decreases schedule growth.

Figure 12. Correlation between project team expertise and schedule growth



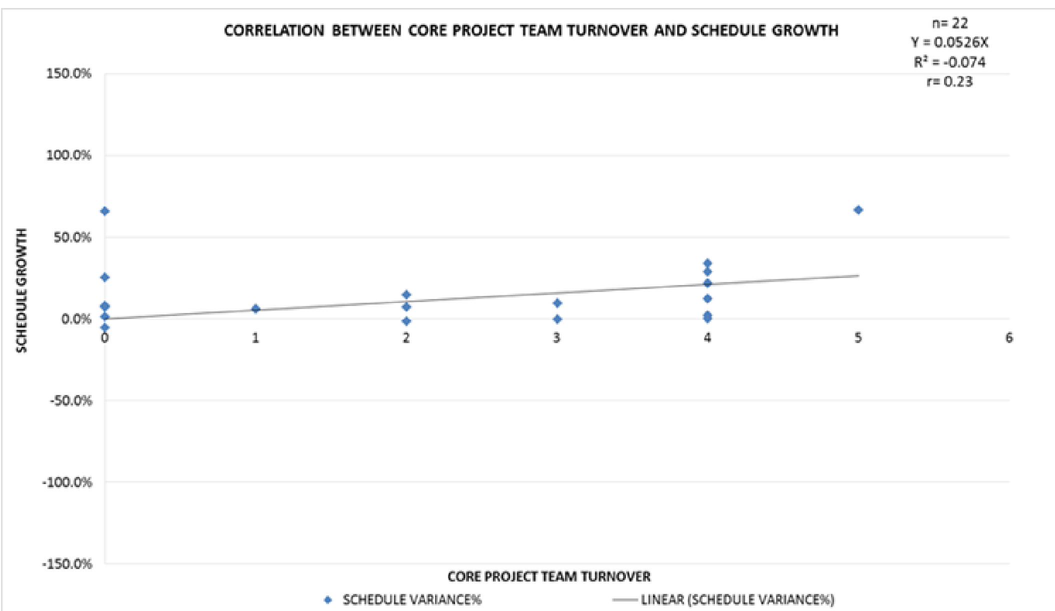
3.2.8. Core project team turnover

Projects teams are composed of various skills and talents, and these teams need to work together utilizing their individual talents in order to execute the projects successfully. Frequent loss or turnover of the project core team members can negatively impact the project. When core people leave the project they take all their learning and experience of the project with them, as all of the project information is not documented. Project team members have their experiences and learning while they are working on projects, once they leave the team and someone else replaces them, the new person has to go through a learning curve in order to start performing at the same pace. This process can slow down the project pace and lead to delays. In order to evaluate the relationship between the core project team turnover and schedule growth, 22 project data was analyzed. As shown in **figure 13**, the researcher found a low degree (r = 0.23) of positive relationship between the core project team turnover and schedule growth. This positive correlation proves that increase in project team turnover increases schedule growth, while a decrease in core project team turnover decreases schedule growth.

3.2.9. Constructability plan integrated

Constructability planning is done by utilizing available knowledge of construction and experience to plan the projects for efficient execution, "through the effective and timely integration of construction input into planning and design as well as field operations will the potential benefits of constructability be achieved [10] (p. 1). Construction Industry Institute [10] (p. 1) further claims that; "constructability results in better projects; lower costs, better productivity, earlier project completions and earlier start-ups". To evaluate the relationship between the constructability plan integration and schedule growth, 42 project data was analyzed. As shown in the **figure 14**, the researcher found a low degree (r = - 0.17) of negative correlation between the constructability plan integrated and schedule growth. This inverse correlation verifies that decrease in integration of constructability plans increases schedule growth and increase in the integration of constructability plans decreases schedule growth.

Figure 13. Correlation between core project team turnover and schedule growth



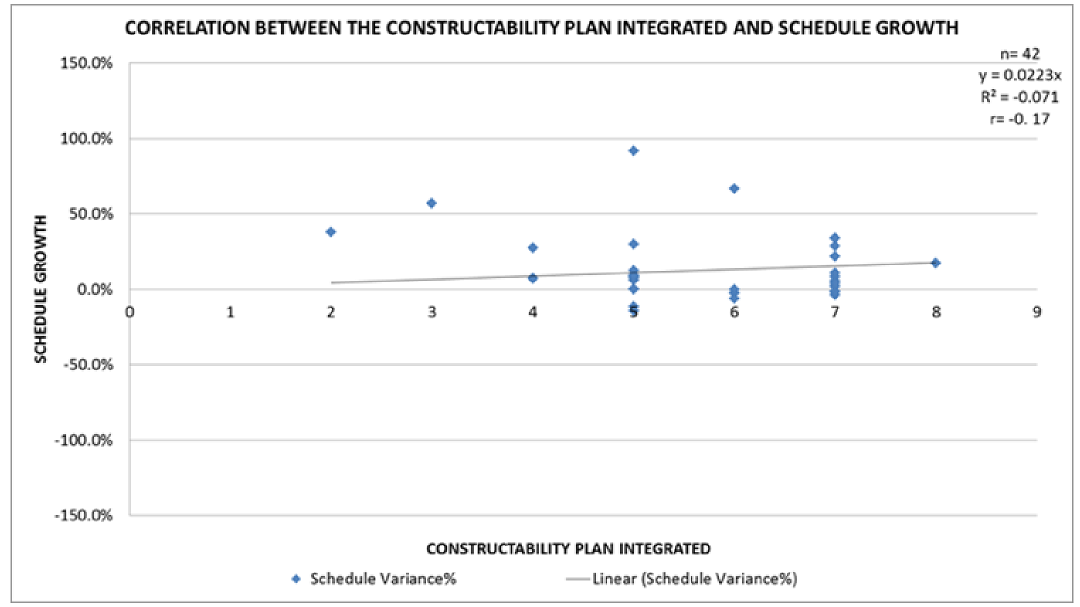
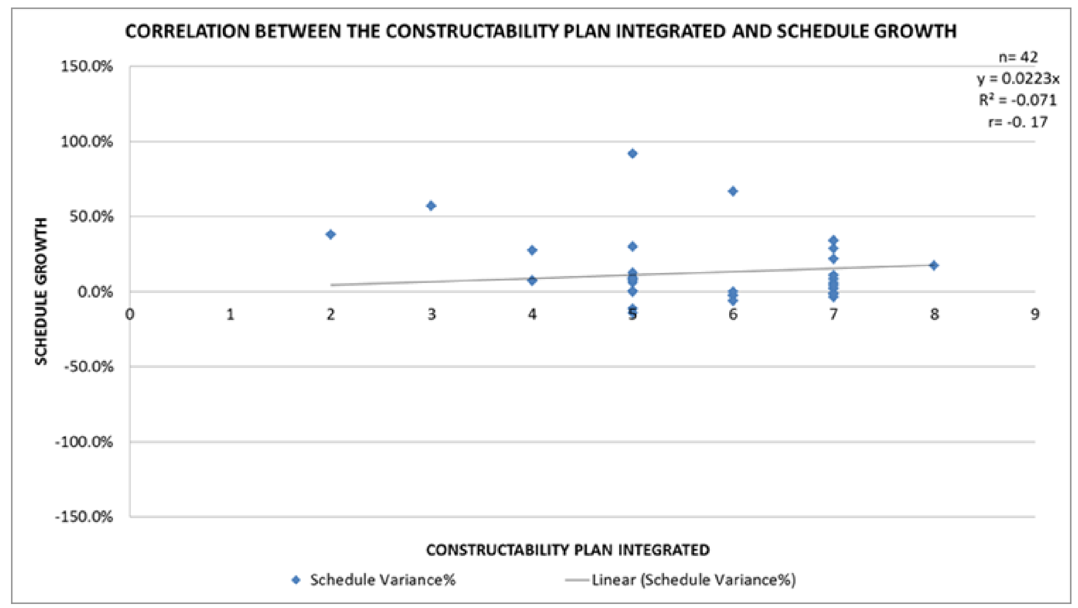


Figure 14. Correlation between constructability plan integrated and schedule growth

3.2.10. Constructability plan success

Success of constructability planning is essential to reap full benefits of committing resources into construction planning and constructability reviews. To evaluate the correlation between the constructability plan's success and schedule growth, 35 project data was analyzed. As shown in the **figure 15**, the researcher found a low degree (r = - 0.17) of negative correlation between constructability plan's success and schedule growth. This proves that increase in constructability plan's success decreases schedule growth and decrease in constructability plan's success contributes to schedule growth.

Figure 15. Correlation between constructability plan success and schedule growth



3.2.11. Construction productivity

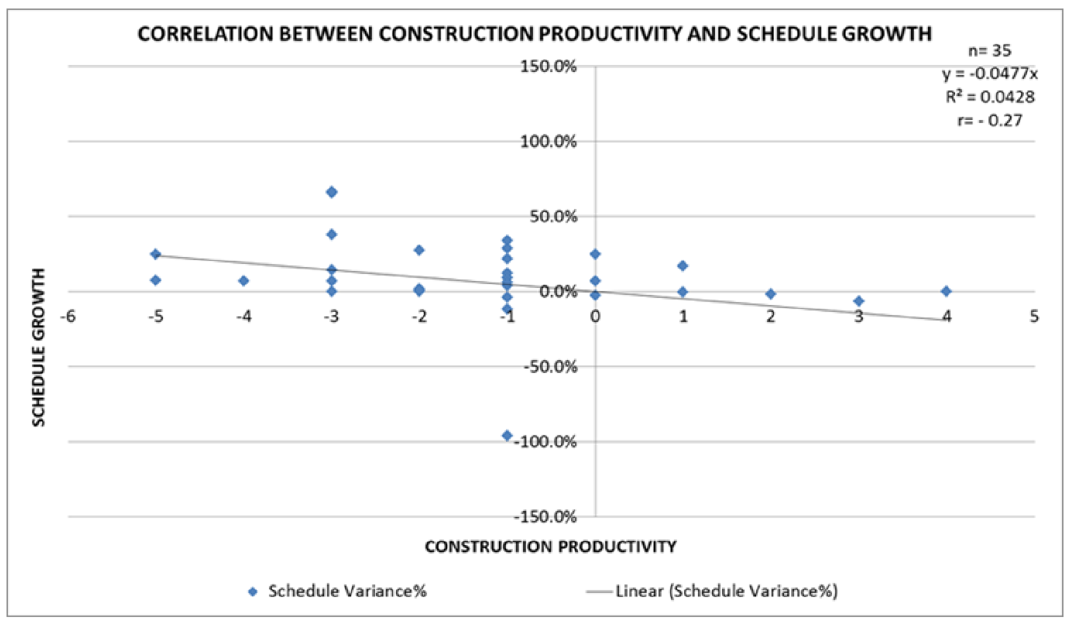
Construction productivity metrics are defined as actual work hours per unit quantity i.e. the number of actual direct work hours to construct a unit quantity [11] (p. 34). Dr. Jergeas & Dr. Ruwanpura [4] has identified construction productivity as one of the challenges faced by the Alberta's oils sands development. With regards to the construction productivity of Alberta projects, the data shows a decrease or consistent level of productivity over the three phases [7] (p. 48). To understand and evaluate the relationship between the construction productivity and schedule growth, 35 project data were analyzed. As shown in the **figure 16**, the researcher found a low degree (r = - 0.27) of negative relationship between the construction productivity and schedule growth. This proves that construction productivity and schedule growth are inversely related, decrease in construction productivity contributes to schedule growth and increase in construction productivity reduces schedule growth.

3.2.12. Risk assessment and risk mitigation planning

Risk management is one of the essential parts of project execution plan and a key focus area for the project management teams. According to the Project Management Body of Knowledge (PMBOK) [11] (p. 310), "to be successful, an organization should be committed to address risk management proactively and consistently throughout the project". Kishk and Ukaga [12] have concluded in their case study that there is a direct relationship between the effective risk management and project success. Proactive risk management is one of the essential activities that project management teams should focus on throughout the lifecycle of a project, as it affects scope, quality, cost and schedule. So it is crucial for project management teams to conduct risk assessment regularly, implement mitigation plans and maintain project risk register as a live document.

To evaluate the correlation between risk assessment and schedule growth, 52 project data were analyzed. As shown in the **figure 17**, the researcher found a low degree (r = - 0.22) of negative correlation between the risk assessment and schedule growth.

Figure 16. Correlation between construction productivity and schedule growth



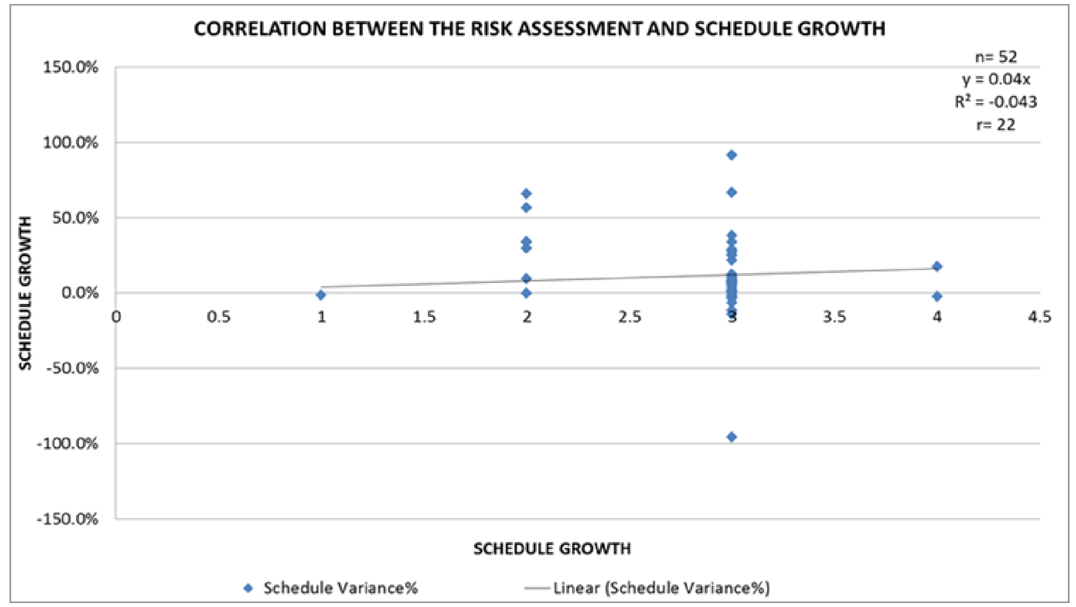
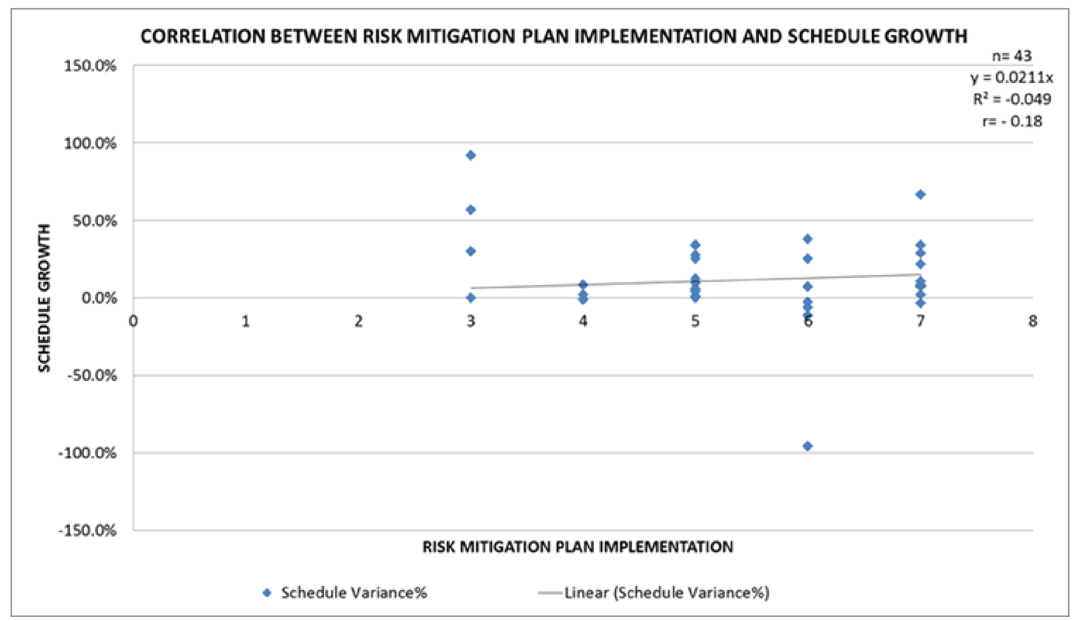


Figure 17. Correlation between the risk assessment and schedule growth

To evaluate the correlation between risk mitigation plan implementation and schedule growth, 43 project data was analyzed. As shown in the **figure 18**, the researcher found a low degree (r = - 0.18) of negative relationship between the risk mitigation plan implementation and schedule growth.

This proves that risk assessment and risk mitigation plan implementations are inversely correlated to schedules growth; decrease in risk assessment and risk mitigation plan implementation contributes to schedules growth, while increase in risk assessment and risk mitigation plan implementation helps reduce schedules growth.

Figure 18. Correlation between risk mitigation plan implementation and schedule growth



4. Summary of Results

Tables 7 summarize overall findings of contextual settings impacting schedule growth; average schedule growth for Alberta projects was at 15.0 % while U.S. projects showed a 5.2 % schedule growth, greenfield projects showed an average growth of 7.4% and brownfield projects showed an average growth of 9.9%, same design team for FEP and detailed design showed 8.7% average schedule growth and different design teams used for FEP and detailed design showed 12.9% average schedule growth, average schedule growth in chemical manufacturing projects was 6.7%, average schedule growth in oil refining was 6.7%, average schedule growth in Oil sands SAGD projects was 12.4%, projects identified as others had an average schedule growth of 9.1%, projects delivered as design-build or EPC had average schedule growth of 7.2%, parallel primes projects showed an average schedule growth of 16.6%, traditional design bid build projects showed average schedule of 7.7% , CM at risk projects showed average schedule growth of 47.3%, and other project delivery methods showed average schedule of 3.8%.

The results data proves that project organizational and contextual settings can put schedule at risk and cause schedule growth. Though project organizations have less control over some of these factors, but there are some factors that project organizations can control by setting up the right project delivery methods, execution strategies and contracting strategies to plan and execute projects of various sizes and levels of complexity. Selecting the right project delivery method and contracting strategy is an important decision that project owner organizations can take by considering the project type, level of complexity, project size, industry environment, available choices of contractors and most importantly what would be the best fit for the project and project owner.

As shown by the results in section 3.2; project execution best practices show a moderate to low-level risk of schedule growth but if not controlled; combined effect of these risk factors can have a huge impact on schedule growth. Schedule growth risk related to the project execution best practices can be mitigated by proper planning and adopting these best practices.

Contextual Factors Impacting Schedule Growth		Average Schedule % Increase
Country of execution	Alberta, Canada	15.0%
	USA	5.2%
Project nature	Greenfield	7.4%
	Brownfield	9.9%
FEP and Detailed Design Teams	Same design team for FEP and detailed design	8.7%
	Different design team for FEP and detailed design	12.9%
Project type	Chemical manufacturing	6.7%
	Oil refining	6.7%
	Oil sands SAGD	12.4%
	Others	9.1%
Project delivery method	Design build or EPC	7.2%
	Parallel primes	16.6%
	Traditional design bid build	7.7%
	CM at risk	47.3%
	Other	3.8%

Table 7. Contextual Factors Impacting Schedule Growth

Project organizations should monitor early signs of milestone delays and trends to effectively manage/mitigate them, ensure accuracy and timely delivery of engineering deliverables, incorporate modularization in the execution, add constructability into their plans, monitor construction productivity and implement proactive risk management system. Best practices like; including providing efficient communication tools to the project teams, including communication matrix in project execution plan, establishing a positive team environment where people can build trust and good working relationship, hire and retain the right talent, and focusing on improving project team's skills and expertise can reduce the risk of schedule growth.

5. Conclusions

The results of this study prove that project's regional, organizational and contextual settings have impact on schedule growth. Though project organizations have less control over some of the factors such as project location or nature of the project, but they can control some of the impact by selecting the right project execution strategies and contractual settings which can benefit project teams during execution. Also this study proves a moderate to low relationship between different project execution best practices with schedule growth. Most of these project execution best practices can help in controlling schedule growth, project organizations are encouraged to focus on applying these best practices during project execution to reduce schedule growth. If not applied proactively, the impact of these factors can create a snowball effect and the cumulative effect can be catastrophic on project schedule, cost and overall success. So project teams should make an effort to continuously monitor and address these factors during project planning and execution phases to controls schedule growth, cost overruns and improve chances of overall project success.

6. Recommendations

Project organizations should consider contextual settings and execution best practices to controls their impact on schedule growth, and build their project execution strategies that takes into account all these factors and address them accordingly. Based on the findings of this study, the researcher provides the following recommendations:

- Project owner organizations use different types of project delivery methods and contracting strategies to plan and execute projects. Selecting the right project delivery method and contracting strategy is an important decision that project owner organizations take considering the project type, project size, industry environment, available choices of contractors and most importantly what would be the best fit for the project and project owner.
- Project owner organizations in Alberta generally hire engineering firms to do the conceptual studies and front-end planning (FEP) and in some cases they hire a different engineering team to do the detailed design after the full project funding approval. New design teams go through orientations and learning curves, which takes time and in many cases projects don't have that kind of time. Project owners should develop a long-term strategy to hire those engineering firms and teams which have the skills and capacity do the detailed engineering as well. This will improve overall design time, create process efficiency and reduce chances of schedule growth during detailed design and construction phases.
- Cost growth and overruns are common in Alberta oil and gas industry projects. This research confirms that cost and schedule growth are positively correlated, increase on leads to growth on the other, so project organizations are recommended to control the causes that lead to cost and schedule growth.
- Accuracy and timely delivery of engineering deliverables are essential to continue with the design development and support other project disciplines to execute project work as planned. Project organizations are recommended to keep focus on slippages of engineering deliverables and engineering milestones. Also, project organizations

- should make an effort to follow the schedule in order to avoid the trickle down effects of engineering delays on ordering material with correct specifications and quantities, avoid filed rework, reduce quality issues and fast-tracking during the construction execution.
- Organizations with established project management offices generally have established project execution strategies that define how to plan, develop and execute projects. These guidelines should also specify the project delivery methodology and contracting strategies for various types of projects. This will bring consistency in project execution, will enable project organizations to benchmark and implement improvements.
- Project communication within project teams and with project stakeholders provides means to transfer information, to communicate progress, to communicate key decisions, coordinate interfaces and to facilitate overall project execution. Project organizations should focus on improving overall project communication by defining communication matrix and protocols for internal communication, communication among project disciplines, communication with external stakeholders, and communication from the senior executives to employees. Also organization should adopt and provide efficient communication tool to the project teams to save time and improve efficiency.
- Project organizations should spend time and effort to hire train and retain skilled employees who have expertise in various project management disciplines. It is essential to provide a positive team environment where project teams can build trust and good working relationships, support each other and maintain a world class performing team environment.
- Project organizations should ensure that proactive risk identification and mitigations is being done throughout the life cycle of a project. Risks affect the scope, quality, cost and schedule,
- so it is crucial for project management teams to conduct risk assessment regularly and keep project risk register as a live document by continuous updates.
- Constructability planning is essential to incorporate construction knowledge and input during planning phase of the project. Projects that incorporate constructability reviews include constructability in their plans and successfully implement constructability during execution can avoid schedule delays and cost overruns and improve chances of project success.
- Project organizations to establish a lessons learned database and ensure that project teams do record lessons learned during all phases of project execution and utilize these lessons on other projects.

Author Contributions: Individual contributions for this research are; conceptualization, TH and GJ; methodology, TH and GJ; validation, TH and GJ; formal analysis, TH; investigation, TH; data GJ; writing—original draft preparation, TH; writing—review and editing, TH and GJ; visualization, TH and GJ; supervision, GJ; project administration, GJ; funding acquisition, GJ.

Acknowledgments: This research acknowledges Construction Industry Institute (CII) and Construction Owners Association of Alberta (COAA) for providing access to project data.

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