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BEST PRACTICES IMPACTING CONSTRUCTION PROJECT SCHEDULE

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Abstract: The heavy industrial sector forms nearly 46% of Canada's goods-producing GDP (Statistics Canada, 2018), making it an important contributor to the national economy. Many of the projects built in this sector, however, experience extended schedules which result in delayed production – ultimately impacting the profitability of companies. The schedule performance of projects can be impacted by many factors, but literature often points to best practices as an effective measure for reducing the chance of schedule extensions. Implementing best practices can be a time-consuming process and therefore their advantages should be well understood by practitioners. To date, the impact of best practices on schedule performance has been studied primarily at the overall project-level but not at the more granular phase-level. The objective of this study is to determine the impact of best practices on the schedule performance of heavy industrial projects at the phase-level. The five project phases considered are Front-End Planning, Detailed Engineering, Procurement, Construction, and Commissioning. A sample of 747 heavy industrial projects from Canada and the United States was analyzed. Inferential statistics such as the *t*-test and Pearson's correlation were used to determine the relationship between best practice use and the schedule growth of each phase. The results of the analysis show which best practices can be used, and to what extent they improve the schedule performance of different phase. The findings can be used by practitioners for selecting the most appropriate best practices for their projects.

1 INTRODUCTION

Studies on construction project delivery very often focus on the schedule performance of projects as it is an important aspect of project success (Lindhard and Larsen, 2016; Rwelamila and Hall, 1995; Chan and Kumaraswamy, 1997). Delivering projects on time is especially important for projects in the heavy industrial sector as the facilities need to be complete for production to commence and generate revenue for companies. However, these projects often experience significant delays and schedule extensions (Fayek et al., 2006; Jergeas and Ruwanpura, 2010) which are linked to poor management practices such as incomplete scope definition, lack of monitoring, control, and site supervision, poor front-end planning, poor or slow communication between project participants, and unforeseen site conditions among other causes (Chanmeka et al., 2012; Jergeas, 2008; McTague and Jergeas, 2002; Okpala and Aniekwu, 1988; Pinto and Slevin, 1987; Sanvido et al., 1992; Chan and Kumaraswamy, 1997; Jha and Iyer, 2006; Chalabi and Camp, 1984). A reduction of delays and extensions may have a positive impact on the revenue of the organizations involved and consequently on the economy as there are more funds to invest in new projects.

Best practices are intended to address some of the causes mentioned above. While definitions and examples of best practice vary based on the industry, in project management they are processes or procedures which have been proven over time to improve chances of project success (CII, 2018; Merriam-Webster, 2018). A number of studies focussing on best practices have found an association between the use of best practices and improved schedule performance in construction projects (Chanmeka et al., 2012; Kang et al., 2013; Jaselskis and Ashely, 1991; Cho et al., 2009; Wang and Gibson, 2010; Ling and Liu, 2004; Wang et al., 2011; Palmer and Mukherjee, 2006). Construction projects, however, transition through a number of phases from start to completion, and little is known on how best practices act on each phase. One of the most common divisions of projects into phases is: Front-End Planning, Detailed Engineering, Procurement, Construction, and Commissioning, with each phase containing a distinct set of tasks and activities. As such, it is important to understand the impact of best practices as they relate to each phase, and whether the impact is the same in each phase.

This study is a continuation of a larger research collaboration between the University of Calgary (UofC), the Construction Owner's Association of Alberta (COAA), and the Construction Industry Institute (CII). The impact of best practices on *cost* performance was determined previously in Robu et al. (2018). The objective of this study is to investigate the impact of best practices on the *schedule* growth of heavy industrial construction project phases. Data on 747 projects from Canada and the United States will be analyzed statistically. Inferential statistics will be used to compare means and determine correlations between the use of best practices and reductions in the schedule growth of each phase. In addition to identifying on which phase a practice exhibits and impact, the magnitude of the impact will also be determined.

2 LITERATURE REVIEW

While schedule is one of the most studied aspects of construction project performance, there are few quantitative studies on the impact of best practices on schedule, and even fewer studies consider a large suite of practices. The description of best practices, and results of previous quantitative research on the topic are described in greater detail below.

Front-end planning and its impact on project performance is very often studied. The intent of this practice is to prepare sufficient information for beginning a project by conducting feasibility analyses, identifying project options, and preparing preliminary designs (CII, 2012). It may also include inviting contractors and consultants into the front-end planning process in order to share their expertise and potentially identify scope gaps or opportunities for greater efficiencies during construction. Front-end planning and its relationship to schedule growth was investigated in a number of studies. Neither Chanmeka et al. (2012) or Kang et al. (2013) found front-end planning to be associated with reduced schedule growth. There are a number of possible reasons for this, including the low sample sizes of the studies and the way in which the implementation of front-end planning was measured. It should also be noted that front-end planning is also used to refer to the first phase of a project in which the aforementioned practices occur, as well as a number of the practices discussed below.

Alignment during front-end planning is a practice in which project participants gain a mutual understanding of the project objectives (CII, 2012) which may include, for example, communicating the operations and maintenance philosophy for the facility. Chanmeka et al. (2012) studied a sample of oil and gas projects and found a statistically significant association between Alignment and decreased schedule factor. Kang et al. (2013) which considered a mixed sample of industrial, building, and infrastructure projects did not find an association between the use of Alignment and schedule growth.

Scope definition is a practice that receives much attention in literature. Typically, the degree of scope definition is measured prior to starting detailed engineering or construction, and its impact on project performance is studied. Scope definition was found to have a positive impact on schedule performance by Wang and Gibson (2010) and was considered by practitioners to be an important element for inclusion into a structural equation model describing project performance (Salazar-Aramayo et al., 2012). Ling and Liu (2004) found that while improved scope definition was not significantly associated with schedule growth, it was related with increased construction and delivery speed. Interestingly, Cho et al. (2009) found the opposite – that increased scope definition was associated with *lower* construction speeds. The author explained that the finding could be attributed to the fact that larger, more complex projects tend to have slower construction speeds but also have greater scope definition, resulting in a correlation that could have been interpreted as increased scope definition causing lower construction speeds. The difference in findings may also be attributed to the makeup of the sample. Overall, studies on scope definition appear to agree that improved scope definition has a positive impact on schedule performance.

Partnering agreements are commitments between two or more organizations that can be long-term or span the duration of a single project. These agreements allow the parties involved to use their human resources more efficiently as collaboration and trust are prioritized over organizational boundaries (Constructing Excellence, 2015; CII, 2012). This practice's impact on schedule growth has not received much attention in literature.

Team building is a practice intended to promote teamwork by building trust between participants and exercising their collaborative problem solving (Wilemon and Thamhain, 1983; CII, 2012). One study that considered team building did not find a statistically significant association with schedule performance (Chanmeka et al., 2012).

Risk assessment is a practice in which various situations, conditions, and impacts to project success are identified (Zavadskas et al., 2010). **Risk mitigation** builds on the risk assessment by identifying strategies for managing the risks identified (PMI, 2013). Most research has focused on risk assessment. Kang et al. (2013) analyzed a mixed sample of projects and found that risk assessment was associated with reduced schedule growth. Chanmeka et al. (2012) considered a smaller sample of only oil and gas projects but did not find a statistically significant correlation between risk assessment and schedule performance.

Constructability as a practice is the incorporation of construction process knowledge into the planning, design, and construction of a project with the intent of streamlining the construction process (CII, 2012). This may result in faster construction and less wasted material. Chanmeka et al. (2012) and Jaselskis and Ashley (1991) found that constructability programs are associated with better schedule performance. Constructability was also found to be a key determinant in a neural network model predicting schedule performance (Kog et al., 1999). One study, however, did not find constructability to be a significant factor impacting schedule performance (Kang et al., 2013). There were also a number of studies which focused on industry practitioner's opinion on best practices. A study by Chua et al. (1999) found that practitioners ranked constructability as an important factor related to schedule performance but Jergeas and Van der Put (2001) found that practitioners believe that the potential benefits of constructability are not fully realized in practice.

Change management is the process of preparing, documenting, and processing changes arising during project execution (PMI, 2013; CII, 2012). Studies on the impact of change management on schedule performance show that there is no statistically significant association (Chanmeka et al., 2012, Kang et al., 2013).

Startup execution plans are meant to capture the activities required to successfully transition the project from construction to a functioning facility (CII, 2012), which is the project phase corresponding to commissioning. Both Chanmeka et al. (2012) and Kang et al. (2013) found that this practice improves schedule performance.

The variability in the results of the above studies can be attributed to a number of reasons. One of these reasons could be the sample which was analyzed. Many of these studies considered a mix of projects from different industries ranging from heavy industrial to buildings to infrastructure. The mixed sample may yield different results as some practices may have a greater impact for certain project types than others. Another characteristic of the sample that can affect results is the sample size. It can be difficult to obtain sufficient project data and therefore the sample sizes in this research area tend to be lower, typically between 20 and 100 projects. Unless analyzed with the appropriate techniques, low sample sizes make it difficult to obtain statistically significant results.

In this study, a larger sample size of strictly heavy industrial projects is used in analysis in order to obtain results that are more applicable to heavy industrial projects. Furthermore, the impact of each of the best practices listed above will be determined at the phase-level, which has not been previously done. The next section will introduce the five project phases and their characteristics.

3 CONSTRUCTION PROJECT PHASES

To ensure data collection yields comparable data between projects, each project phase has defined start and end conditions as well as a description of the activities and deliverables associated with it. The definitions of each project phase as described in the metrics definition document by COAA and CII (2007) are summarized below:

Front-End Planning is the first phase of a project with the start being defined at the point which a single project is adopted and a formal project team is established. Activities in the Front-End Planning phase typically consist of options analysis, project scoping, and life-cycle analyses. Deliverables during this phase include procurement plans, project execution plans, architectural renderings, P&ID's, and site layouts. The phase is considered over on project sanction.

Detailed Engineering typically follows immediately after the Front-End Planning phase and begins when a contract is awarded to an engineering firm. Activities and deliverables during Detailed Engineering include drawings and specifications, bill of materials, procurement status, sequence of operations, technical review, and definitive cost estimates. This phase concludes when all approved drawings and specifications are released for construction.

The **Procurement** phase also begins soon after the Front-End Planning phase ends, once a procurement plan for engineered equipment is in place. This phase consists primarily of vendor qualification and inquiries, bid analysis, purchasing, expediting, transportation, and vendor quality assurance and control. Once all major equipment has been fabricated and is delivered to site the Procurement phase is considered complete.

Construction begins with the commencement of foundations or pile-driving. Activities during construction include mobilization/demobilization, issuing subcontracts, planning construction methods/sequence, building the facility and installing engineered equipment. Once the facility achieves mechanical completion the Construction phase is considered complete.

The final phase is **Commissioning**. This phase begins when the facility achieves mechanical completion and involves system testing, operator training, documentation of results, introduction of feedstocks to obtain the first product, and warranty work. The Commissioning phase ends when custody is transferred to the operator.

To visualize a typical project schedule composed of the five phases, data on durations, start, and end dates are averaged and displayed in a bar chart in Figure 1. It can be seen that there is significant overlap between the Detailed Engineering, Procurement, and Construction phases. The Front-End Planning phase, however, has almost no overlap with any other phase. In terms of duration, the Procurement and Construction phases are the longest at over 40% of the project duration while Commissioning is the shortest at 9% of the project duration. While the project schedule is much more complex and is formed through interrelated activities that transcend phases, the illustration provides a high-level view of the phase schedule of heavy industrial projects. The schedule will help in the following sections with understanding where best practices are acting and how they may have an impact on the overall schedule.

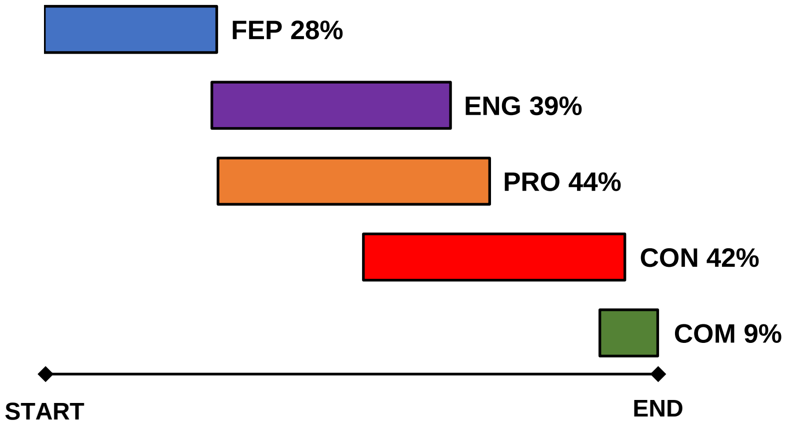

Figure 1. Average Project Schedule with Phase Durations

4 DATA SOURCE AND STRUCTURE

A total of 747 heavy industrial projects are used in this study. The projects range in size from $60,000 USD to 16B USD and the majority are located in the United States (649) with the remaining projects located in Canada (98). Most projects in this sample were constructed between the years 1990 and 2015. Data on the phase start and end date, duration, and best practice use was extracted from each project. This information was populated via an online survey into the CII/COAA database by industry practitioners who were involved in the respective project.

Schedule data is captured through simple inputs requesting dates and durations, which will be used to describe schedule performance. The use and implementation of best practices, however, are captured through one or more questions. The questions are either dichotomous (yes/no) or on a Likert scale. The analysis method will depend on the way in which a best practice was measured. Data on Front-End Participation, Alignment, Partnering, and Team Building was captured by asking if the practice was, or was not implemented on the project. Aspects of Operations and Maintenance Philosophy, Scope Definition, Risk Assessment, Risk Mitigation, and Startup Execution Plans were measured on a Likert scale. Practices such as Constructability and Change Management used both measurement methods.

5 ANALYSIS METHODOLOGY

In this study, the schedule performance of each phase will be described by Schedule Growth, SG_p, as follows:

$$SG_P = \frac{S_{PA} - S_{PB}}{S_{PB}} \tag{1}$$

where P is one of the five phases (Front-End Planning, Detailed Engineering, Procurement, Construction, Commissioning), S_{PA} actual phase duration, and S_{PB} is the planned phase duration. Inferential statistics is typically used to establish if an association exists between two variables, with resulting *p*-values less than 0.05 being considered statistically significant in project management research (Fellows and Liu, 2008). The way in which best practices are measured will determine which inferential test is used as follows:

> **Practices measured dichotomously** (yes/no) will be tested using the *t*-test, which tests if the mean Schedule Growth is different (at $p<0.05$) for projects that did or did not implement a practice. The difference in means can be used as the magnitude of impact directly.

Practices measured on a scale will be tested using Pearson's correlation, which determines the degree of association between two variables. As correlations only indicate the strength of the association, a simple linear regression will also be conducted to obtain the magnitude of impact a practice will have (via the regression coefficient).

Parametric tests such as the *t*-test and Pearson's correlation have a number of assumptions that need to be satisfied to be confident that the results are completely valid. Shapiro-Wilks tests on the data show that the normality assumption is not satisfied. As such, equivalent nonparametric tests – Mann-Whitney U-test and Spearman's correlation will be used alongside the *t*-test and Pearson's correlation when the normality assumption is not met. Non-parametric tests generally do not have assumptions on the distribution of data and are much less susceptible to outliers, however, they also tend to have less power (Colquhoun, 1971) and the results are more difficult to interpret than those of parametric tests. In order to account for the violation of assumptions of parametric tests, and the disadvantages of non-parametric, the results of both tests will be considered in determining the statistical significance of a best practice's impact.

6 IMPACT OF BEST PRACTICES ON SCHEDULE GROWTH

Statistically significant results of tests between each practice and phase Schedule Growth are shown in Table 1. Seven of the ten best practices tested had a statistically significant impact on phase Schedule Growth. Three of the practices – Front-End Participation, Team Building, and Change Management – impact multiple phases. It is interesting to note that Front-End Participation and Team Building *increase* the Schedule Growth of the Front-End Planning Phase but *decrease* the Schedule Growth of the Detailed Engineering phase. A count of the statistically significant practice-phase pairs shows that the Construction phase by far benefits from more practices than any other phase, with five practices having an impact versus other phases that are only impacted by three or less practices.

Table 1. Magnitude of Best Practice Impact on Schedule Growth

Best Practice	**Phase**				
	FEP	**ENG**	**PRO**	**CON**	**COM**
Front-End Participation	**+11%**	**-10%**			**-12%**
Scope Definition				**-40%**	
Partnering Agreement				**-14%**	
Team Building	**+7%**	**-8%**			
Risk Assessment				**-29%**	
Constructability Plan			**-11%**		
Change Mgmt Documented		**-28%**		**-18%**	
Change Mgmt Understood				**-14%**	

In addition to the impact of practices on each phase, it is helpful to be able to rank the practices by their overall impact. Insufficient data on the overall project schedule meant that it was not possible to conduct statistical tests on the impact of practices for the entire project schedule. As an alternative, the magnitude of impact in each phase was weighted by the average duration of each phase. The resulting Weighted Magnitude is shown in Table 2 and helps in separating practices that have a "high" impact from those that have a "low" impact. Scope Definition, Risk Assessment, and Change Management all have a weighted magnitude of more than 10%. The remaining practices – Front-End Participation, Partnering Agreement, Team Building, and Constructability Plans – have a Weighted Magnitude less than 10%.

Table 2. Best Practice Weighted Magnitude of Impact

Best Practice	Weighted Magnitude
High Impact (< -10%)	
Change Management Documented	-18%
Scope Definition	-17%
Risk Assessment	-12%
Low Impact (> -10%)	
Partnering Agreement	-6%
Change Management Understood	-6%
Constructability Plan	-5%
Front-End Participation	-2%
Team Building	-1%

7 CONCLUDING REMARKS

The purpose of this study was to investigate the impact of best practices on the schedule performance of each phase of heavy industrial projects. It was found that seven of the ten practices considered in this study impacted at least one phase, with some practices impacting a number of phases. Three practices were found to be more impactful than others through the Weighted Magnitude – Change Management, Risk Assessment, and Scope Definition. These three practices are also intended to directly address some of the causes of schedule overruns that were mentioned in the introduction.

Taking a higher-level view of the meaning and intent of the best practices which showed an impact leads to the conclusion that a greater degree of planning and forethought (Scope Definition, Risk Assessment, Constructability, Front-End Participation), well-understood processes (Change Management), and better relationships between stakeholders/project team (Partnering Agreement, Team Building) leads to better schedule performance.

By determining the impact of practices at a more granular level, the findings of this study can help practitioners in deciding on the most appropriate practice to implement by highlighting which phase(s) a practice impacts, and the magnitude of that impact. Alternatively, practitioners could use the Weighted Magnitude as a guide for selecting the highest-impact practices. The magnitude of impact could also be combined with data on the cost or time investment of implementing a practice in order to determine the benefit/cost ratio. Lastly, the study has shown how each phase behaves differently with regards to the impact of best practices on different phases. It is speculated that the nature of the activities and deliverables of each phase may partially explain why some best practices impact the duration of specific phases. In conclusion, this study offers a new perspective on analysing project performance by dividing projects into distinct phases and identifying methods of improving each individual phase as opposed to the entire project as a whole.

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9 REFERENCES

Chalabi, F. A. and Camp, D. 1984. Causes of delays and overruns of construction projects in developing countries. *Proceedings of the CIB*, **2**(65), 723-734.

Chan, D. W. M. and Kumaraswamy, M. M. 1997. A comparative study of causes of time overruns in Hong Kong construction projects. *International Journal of Project Management*, Elsevier, **15**(1), 55-63.

Chanmeka, A., Thomas, S. R., Caldas, C. H. and Mulva, S. P. 2012. Assessing key factors impacting the performance and productivity of oil and gas projects in Alberta. *Canadian Journal of Civil Engineering*, NRC Research Press, **39**(3), 259–270.

Cho, K., Hong, T. and Hyun, C. 2009. Effect of project characteristics on project performance in construction projects based on structural equation model. *Expert Systems with Applications*, Elsevier, **36**(7), 10461–10470.

Chua, D. K. H., Kog, Y. C. and Loh, P. K. 1999. Critical Success Factors for Different Project Objectives. *Journal of Construction Engineering and Management*, ASCE, **125**(3), 142–150.

Colquhoun, D. 1971. *Lectures on biostatistics: An introduction to statistics with applications in biology and medicine*. Oxford: Clarendon Press.

Construction Owners Association of Alberta (COAA), Construction Industry Institute (CII). 2007. Performance Metric Formulas and Definitions. Accessed February 23, 2018. https://www2.construction-institute.org/nextgen/publications/coaa/general/COAA_Metrics_Definitions_Nov16_07.pdf

Construction Industry Institute (CII). 2012. Benchmarking & Metrics Project Level Survey, Version 11 (Large Project Questionnaire). Accessed February 23, 2018. https://www2.construction-institute.org/nextgen/publications/pas/general/Large_Project_Version11_Issued_092012.pdf

Construction Industry Institute. 2018. Knowledge Base – Best Practices. Retrieved from https://www.construction-institute.org/resources/knowledgebase/best-practices on October 23, 2018

Constructing Excellence. 2015. Partnering. Retrieved from http://constructingexcellence.org.uk/wp-content/uploads/2015/03/partnering.pdf on October 23, 2018

Fayek, A.R., Revay, S.O., Rowan, D., Mousseau, D. 2006. Assessing performance trends on industrial construction megaprojects. *Cost Engineering*, ProQuest, **48**(10), 16–21.

Fellows, R.F. and Liu, A.M. 2008. *Research Methods for Construction*. Wiley-Blackwell Publishing, West Sussex, UK.

Jaselskis, E. J., Ashley, D. B. 1991. Optimal Allocation of Project Management Resources for Achieving Success. *Journal of Construction Engineering and Management*, ASCE, **117**(2), 321–340.

Jergeas, G. 2008. Analysis of the front-end loading of Alberta mega oil sands projects. *Project Management Journal*. Wiley Interscience, **39**(4), 95–104.

Jergeas, G., Put, J. Van der. 2001. Benefits of Constructability on Construction Projects. *Journal of Construction Engineering and Management*, ASCE, **127**(4), 281–290.

Jergeas, G. F., Ruwanpura, J. 2010. Why Cost and Schedule Overruns on Mega Oil Sands Projects?. *Practice Periodical on Structural Design and Construction*, ASCE, **15**(1), 40–43.

Jha, K.N., Iyer, K.C. 2006. Critical factors affecting quality performance in construction projects. *Total Quality Management & Business Excellence*, Taylor and Francis, **17**(9), 1155-1170.

Kang, Y., O'Brien, W. J., Butry, D., Thomas, S. P., Mulva, S. P., Dai, J., Chapman, R. E. 2013. Interaction Effects of Information Technologies and Best Practices on Construction Project Performance. *Journal of Construction Engineering and Management*, ASCE, **139**(4), 361–371.

Kog, Y. C., Chua D. K. H., Loh, P. K., Jaselskis, E. J. 1999. Key determinants for construction schedule performance. *International Journal of Project Management*, **17**(6), 351–359.

Lindhard, S., Larsen, J. K. 2016. Identifying the key process factors affecting project performance. Engineering, *Construction and Architectural Management*, Emerald, `**23**(5), 657-673.

Ling, F. Y. Y., Liu, M. 2004. Using neural network to predict performance of design-build projects in Singapore. *Building and Environment*, Elsevier, **39**(10), 1263–1274.

McTague, B., Jergeas, G. 2002. *Productivity improvement on Alberta major construction projects, Phase I-Back to Basics*. Construction Productivity Improvement Report, Alberta Economic Development Board.

Merriam-Webster. 2018. Best Practice (noun). Retrieved from https://www.merriam-webster.com/dictionary/best%20practice on October 23, 2018

Okpala, D. C., Aniekwu, A. N. 1988. Causes of High Costs of Construction in Nigeria. Journal of Construction Engineering and Management, ASCE, **114**(2), 233–244.

Palmer, J., & Mukherjee, T. 2006. Keynote: Megaproject Execution. *SPE Annual Technical Conference and Exhibition*, Society of Petroleum Engineers, San Antonio, Texas U.S.A.

Pinto, J. K., Slevin, D. P. 1987. Critical factors in successful project implementation. *IEEE Transactions on Engineering Management*, **EM-34**(1), 22–27.

Project Management Institute. 2013. *A Guide to the Project Management Body of Knowledge (PMBOK Guide)*. 5th ed., PMI, Newton Square, PA, USA.

Robu, M., Sadeghpour, F., Jergeas, G. 2018. Best Practices Impacting the Cost Performance of Heavy Industrial Projects. Canadian Society for Civil Engineering, CSCE, Fredericton, NB, Canada

Rwelamila, P. D., Hall, K. A. 1995. Total systems intervention: an integrated approach to time, cost and quality management. *Construction Management and Economics*, Taylor and Francis, **13**(3), 235-241.

Salazar-Aramayo, J. L., Rodrigues-da-Silveira, R., Rodrigues-de-Almeida, M., de Castro-Dantas, T. N. 2013. A conceptual model for project management of exploration and production in the oil and gas industry: The case of a Brazilian company. *International Journal of Project Management*, Elsevier, **31**(4), 589–601.

Sanvido, V., Grobler, F., Parfitt, K., Guvenis, M., Coyle, M. 1992. Critical Success Factors for Construction Projects. *Journal of Construction Engineering and Management*, ASCE, **118**(1), 94–111.

Statistics Canada. 2018. Table 36-10-0434-06 Gross domestic product (GDP) at basic prices, by industry, annual average, industry detail (x 1,000,000). Retrieved from https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3610043406 on December 2018

Wang, Y.-R., Gibson Jr, G. E. 2010. A study of preproject planning and project success using ANNs and regression models. *Automation in Construction*, Elsevier, **19**(3), 341–346.

Wang, Y.-R., Yu, C.-Y., Chan, H.-H. 2011. Predicting construction cost and schedule success using artificial neural networks ensemble and support vector machines classification models. *International Journal of Project Management*, Elsevier, **30**(4), 470–478.

Wilemon, D. L., Thamhain, H. J. 1983. Team building in project management: Secret Ingredients for Blending American and Japanese Management Technology. *Project Management Quarterly*, PMI, **14**(2), 73–81.

Zavadskas, E.K., Turskis, Z. and Tamošaitiene, J. 2010. Risk assessment of construction projects. *Journal of Civil Engineering and Management*, Taylor and Francis, **16**(1), 33-46.