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EMPLOYERS’ AND CONTRACTORS’ PERSPECTIVES ON THE TREATMENT OF THE VOLUME OF CONSTRUCTION CONTRACT CHANGES

by
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ABSTRACT
OF THE THESIS OF

Rawad Ayman El Masri for Master of Engineering
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Title: Employers' and Contractor's Perspectives on the Treatment of the Volume of Construction Contract Changes

Construction contract variations have been the core and pre-eminent genesis for the delay of, disruption in, and cost overrun of construction projects. In the case of construction projects suffering a substantial number of changes, contractors' claims can become complex whereby it might become extremely difficult to accurately account for all impact costs resulting therefrom including costs which cannot be directly attributable to a specific change, not ready foreseeable, and/or if foreseeable, not readily computable as they are a result of the synergistic effect of changes. The contractor therefore is only reimbursed for direct impact costs and thereby obtains a compensation that is actually less than the full compensation for the change orders and variations being negotiated and/or for which consensual negotiation has been completed and the related cost and time implications have been agreed upon This gives rise to different perspectives between employers and contractors in relation to the treatment of the large volume of changes and thus to different approaches in packaging contract variations related claims. Accordingly, this might establish grounds for filing for cumulative impact claims and/or cardinal change claims. This research thus aims to (1) investigate different contractors' and employers' perspectives in expressing and treating the large volume of changes involved in construction projects including potential and uncommon contractor's approaches in packaging and filing claims related to contract changes, (2) define what constitutes a cumulative impact claim and a cardinal change, (3) deduce the success and failure criteria and the legal/contractual consequences of these claims, and (4) identify contractors and employers strategies to avoid/mitigate such claims (Pre and Post Contract signature). There is not enough research concerning this topic in the literature and there exists a gap in addressing the admissibility and treatment of the abovementioned claims resulting from substantial amount of construction contract variations. The findings revealed (1) key success and failure criteria for cumulative impact claims and cardinal change claims, (2) guidelines that shall establish whether a change will qualify for a cardinal change along with the legal consequences if the same had been induced, and (3) different contractor's and employer's strategies and perspectives in dealing with the large volume of changes.

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INTRODUCTION

1.1 Research Background:

Construction contract variations in construction projects have proved to be inevitable (El-adawy et al. 2016) and an inherent part of the construction industry (Khalifa and Mahamid, 2019). The chances of completion of construction projects without any changes would certainly mean that the design process, coordination, and communication between the project participants was ideal and exemplary (Hanna and Swanson, 2007). It is regarded that any additions, revisions, or deletions to project goals or the contemplated scope of work are considered to be changes; regardless of whether they increase or decrease the project cost or schedule (Ibbs et al. 2001).

Changes come in different forms and each has its own legal consequences (Hanna and Swanson, 2007). A directed change order can be defined as “any event, which results in a modification of the original scope, execution time or cost of work” (Ibbs and Allen, 1995). According to (AIA 2007a; ConsensusDocs 2011) it is also defined as a written order agreed upon by the employer, designer, and contractor that authorizes a change to the scope of work, the contract time, and/or the contract sum; They are generally introduced by the employer and/or its authorized representative in line with signed contract stipulations. A constructive change is when the contractor views that a certain change includes an increase in scope and thus entitles the contractor for compensation in relation thereto; however, the same is regarded by the employer as being part of the contemplated scope under the contract (Hanna and Swanson, 2007; Lee, 2002). Minor changes are also those regarded by the employer or its authorized representative as being consistent with contract documents and do not affect the contract price and/or completion date (Lee, 2002).

The above forms of changes among others, are a result of many causes including and not limited to lack of proper coordination and effective communication between project participants, lack of integration, uncertainty, design changes or errors, scope additions, insufficient development of design prior to construction, increase in project complexity, safety considerations, substitution of materials, project planning deficiencies, unknown site conditions, schedule compression and unexpected weather conditions among many others (Naoum, 1994; Hanna and Iskandar, 2017; Hanna, 2001).

Standard construction contracts include clauses which in terms authorize the employer or its representatives/personnel to introduce changes to the works and require from contractors to proceed with same (El-adaway et al. 2016).

Notwithstanding, changes and variations to the works have been regarded as one of the major causes of delay, disruption, cost overruns and disputes between the contracting parties (Motawa et al. 2007). Change orders have also been identified to incur negative impacts on labor productivity which in terms affects the overall efficiency of the construction process and cause considerable loss of man hours (Moselhi et al., 2005; Hanna 2001; Jones 2001; Yi and Chan 2013).

If the employer and contractor fail to agree on the adjustments pertaining to contract time and contract cost, variations performed by the contractor under protest (including constructive changes, interim changes, or change directives) would be subject to claims and disputes (Syal and Bora 2016; El-adaway, 2016); The focal point of dispute in change order processes has been cost (Syal and Bora, 2016).

The contractor shall thereby indicate that the works related to the introduced changes will be performed but shall concurrently comply with notice requirements and assert that a claim will be submitted at a later date (Hanna and Swanson, 2007).

In light of the above, variations to the works produce an atmosphere of negativity for both employers and contractors whereby employers would be set to believe that changes incur additional costs as a result of mistakes made by others (designer, CM, …) and contractors, might suffer from delay, disruptions and additional paper work (Khalifa and Mahamid, 2019). In addition to the latter, most contractors believe that change orders and variations are generally not profitable as they might end up executing the works with lower markup and profit than that accounted for in their initial bid (Syal and Bora, 2016).

Accordingly, disputes over the admissibility of the submitted claims and the contractor's right for compensation might rise to the level of resorting to arbitration, litigation, or other forms of alternative dispute resolution processes in line with contract conditions and stipulations (Muller, 1990; Steen, 1994; Keith, 1997; Schumacher, 1997). According to Abdul-Malak et al. (2002), the process of resorting to litigation in an attempt to resolve disputes over unsettled claims can take a very long time in addition to the fact of being exhausting and expensive.

1.2 Problem Statement:

Construction contract variations have been the core and pre-eminent genesis for the delay of, disruption in, and cost overrun of construction projects. Failure by the contracting parties to agree to the cost and time implications resulting therefrom has given rise to claims that have been the major cause of disputes, which vary infinitely in terms of their level of complexity, detail, required burden of proof, legal consequences and the disputed over cost and time implications.

To this effect, in the case of construction projects suffering a substantial number of changes, contractors claims can become complex whereby it might become extremely difficult to accurately account for all impact costs resulting therefrom, including costs which cannot be directly attributable to a specific change, not readily foreseeable and/or if foreseeable, not readily computable as they are a result of the synergistic effect of changes. In this regard, the establishment of causal nexus and the attempt to directly attribute the loss to specific head of claim or change order might become impracticable and sometimes impossible.

Therefore, the contractor only recovers direct impact costs and thereby obtains a compensation that is actually less than the full compensation for the change orders and variations being negotiated and/or for which consensual negotiation has been completed and the related cost and time implications has been agreed upon.

After having already agreed to the individual impact of each change order/variation, contractors' attempt to recover unrecovered/unforeseeable cost and time implications (as mentioned above) via different approaches which in term are related to its own perspective in treating the large volume of experienced contract changes. This thereby might establish the ground for filing for cumulative impact claims (Centex Bateson Construction Co v. West (2000); Pittman Construction Company Co. v. United States; Jackson Construction Co. Inc v. United States; etc.), and/or global claims (John Doyle Construction Limited v. Laing Management (Scotland) Limited (2004); Holland Construction and Engineering Pty Ltd. v. Kvaener RJ Brown Pty Ltd.,Byrne J; etc.), and thus open grounds for the contractor to package its claims as a whole basket. In this context, contractors might also attempt to claim that the volume of introduced variations has amounted to a cardinal change (*Atlantic Dry Dock Corp. v. United States (1991); General Contracting and Construction Co. v United States; P.L Saddler v. Unites States; etc*.) that has caused the work to be materially different from that contemplated for under the contract and in some cases qualifying to declare frustration of contract.

Accordingly, the large volume of contract variations can be viewed and expressed differently by the employer and the contractor. This gives rise to different perspectives in relation to the treatment of the large volume of changes and thus to different approaches in packaging contract variations related claims. In this regard significant questions shall also be analyzed and answered:

1. Has the contractor waived its rights to collect for unrecovered and unforeseeable cumulative impacts (collective synergistic effect) resulting from the large volume of changes after having already signed and agreed as to the individual/sole cost and time implications of these changes?
   If not, what are the success and failure criteria of cumulative impact claims, global claims and cardinal change claims and what are the different perceptions/approaches that the contractor can opt for in packaging its claims as a whole basket? On the other hand, what are potential employer defenses/perceptions in relation thereto?
2. What is the criteria that classifies a change as a cardinal change and what are the legal contractual consequences if the contractor claimed that a cardinal change has been induced? Could it lead to contract frustration and annulment?

3. Can a cardinal change be a result of a single change or shall it be a result of a series of changes that amount to a significant deviation from the contemplated scope of the project?

The literature does not seem to provide an in depth review and analysis on the above questions and on the admissibility of the different contractors' perspectives in expressing the total volume of the encountered changes as a mean to recover its total encountered cost overruns.

It shall also be noted that further to the above, there is no definite definition/criteria to what classifies a claim to be, a cumulative impact claim, and/or amounts to a cardinal change to the works and no clear study which encompasses the potential legal consequences of opting to package contractual claims in such ways. Moreover, courts' decisions have altered the way the legal system allocates liabilities and risks associated with changes in the construction industry and developed new legal principles in this regards.

Please refer to the below figure (Figure 1) which aims to visualize the problem statement discussed above.

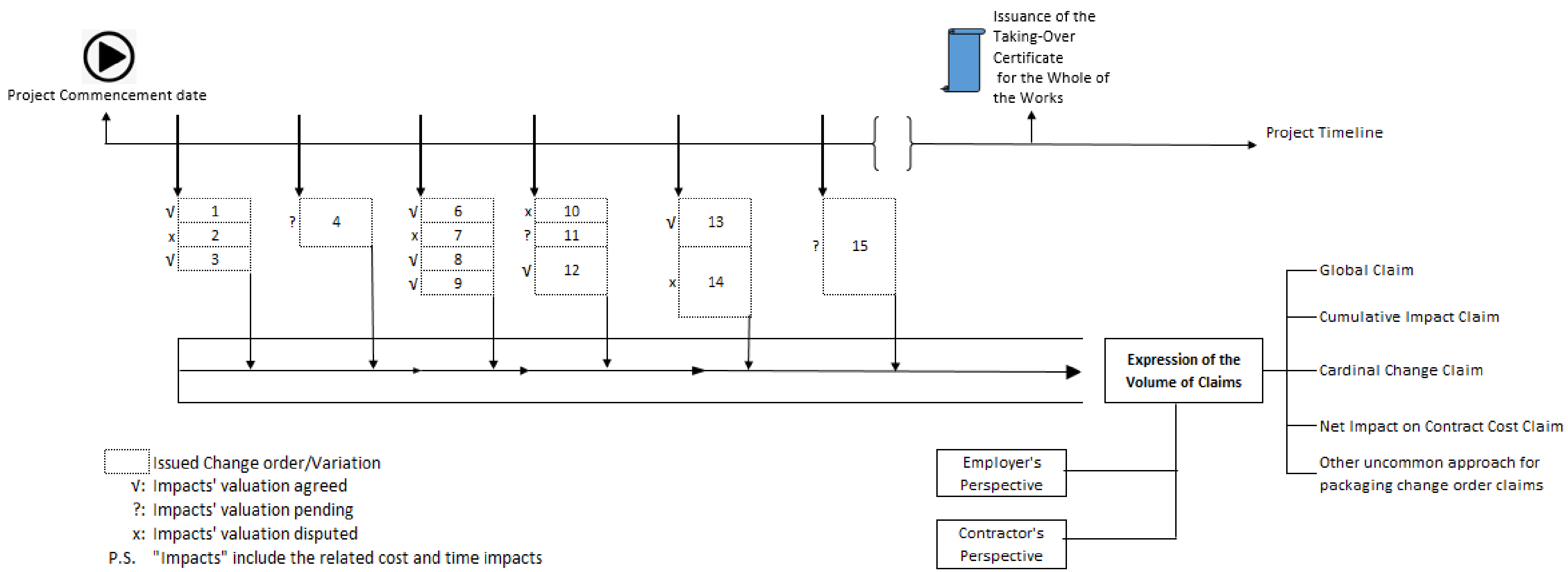

Figure 1: Increase of the volume of changes throughout the project lifetime

1.3 Research Goal and Objective:

In light of the above, the overall goal of this research is to:

- Investigate different contractors' and employers' perspectives in expressing and treating the volume of changes involved in construction projects including potential and uncommon contractor's approaches in packaging and filing contract changes' related claims; particularly in construction projects which experience a substantial amount of change orders and multiple claim-causing events for which the employer/engineer is responsible.
- Define what constitutes a cumulative impact claim, and a cardinal change, deduce the success and failure criteria and the legal/contractual consequences of these claims, and identify contractors and employers strategies to avoid/mitigate such claims (Pre and Post Contract signature).

1.4 Methodology:

To achieve the above objectives and effectively tackle the problem statement, the following methodology will be followed; as illustrated by the figure below (Figure 2):

1. Conducting a literature study which includes a thorough reading of a wide-spread assortment of related articles, journals, books etc…
2. Examining case law and legal principles; this includes reviewing the current and historical developments in case law and legal principles whilst focusing on case law which represented a main shift in the legal analysis of the above. (Legal and contractual analysis in regard to the admissibility of these claims will also be conducted).

3. Examining the record of two cases that represented different employer's and contractor's perspectives in regard to treating the large volume of contract variations:

- **<u>Case 1:</u>** Represents the contactor's attempt to package its claim through perceiving that a whole integrative item/system has been impacted by a certain change order/contract variation despite the fact that the contract variation(s) had only modified/affected a part/percentage and/or one element of this item. The contractor thereby claims that a substantial percentage of the contract price has been affected by variations; as a matter of fact, the employer's attempt to prove that only specific parts of these items were affected by a change order/contract variation and thus the impact on the contract price is minimal or considerably lower than that perceived by the contractor.
- **<u>Case 2:</u>** Employer expresses the volume of the contract variations using the "net impact on contract price" approach to diminish the impact of same whereby the contractor on the other side opts to express the volume of contract variations using the "absolute impact on the contract price" as a way to recover its encountered losses.

4. Deducing the legal repercussions and contractual consequences of attempting to file for cumulative impact claim and of that in the case where a cardinal change has been induced and validated.
5. Deducing the success and failure criteria of cumulative impact claims and cardinal change claims in addition to establishing what constitutes such claims.

6. Identifying contractors' strategies and identifying quantification methods that can be used to prove the admissibility of these claims (i.e. establish causation and resultant injury) in order to defeat potential employers' defenses hindering the success of the same.
7. Providing a comprehensive summary of research outcomes in addition to conclusion and recommendations. Future work in this field of study will also be suggested.

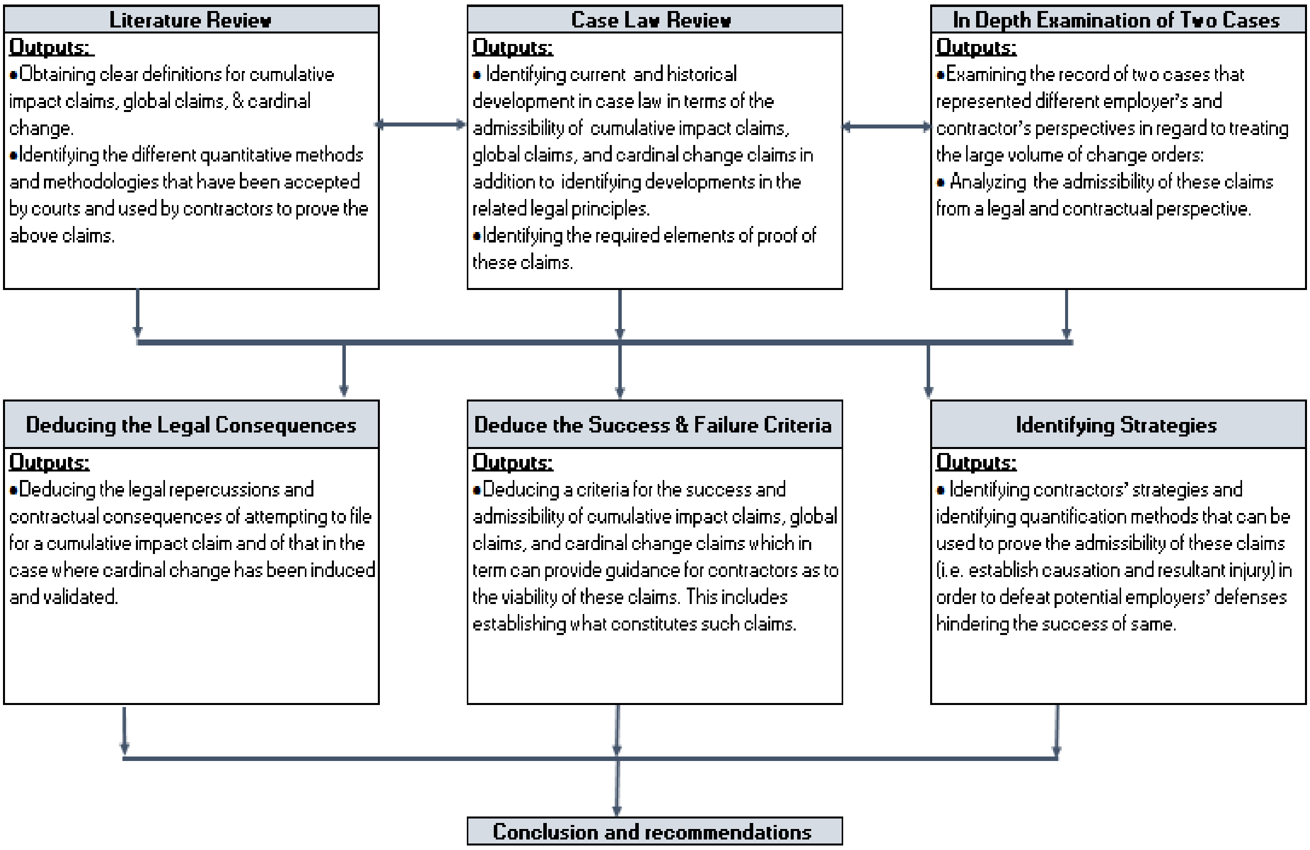

Figure 2: Research Methodology

1.5 Significance of the Research:

In light of the above, contractors tend to minimize their losses and recover unforeseeable cost overruns and extra works that are considered to be a result of employers' directed changes.

The merits of this research will guide contractors to the admissibility and viability of cumulative impact claims and cardinal change claims in addition to establishing a criteria that can be utilized by the contractor for the success of these claims. Moreover, guidelines will be established for classifying claims as quantifying to be a cardinal change to the stipulated scope of work along with analyzing the legal consequences and principles related to the same, particularly its interrelationship with contract frustration. In addition, the proposed guidelines would help contractors effectively manage contract variations impacts through implementing change management procedures and thus avoiding the burden of resorting to uncommon approaches and perspectives in treating the large volume of contract changes which can be faced by counter-employers' defenses and perceptions in relation thereto. This research can accordingly fill significant gaps in the related literature and have effect in better approaching the issues of filing for cumulative impact claims and cardinal change claims.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction:

As highlighted above, construction contract variations widely exist in the construction industry and are consistently associated with challenges for project practitioners (Ibbs et al., 2001). The latter have been one of the major causes of cost overrun, project delay and disputes between the parties to the contract (Finke, 1999; Jones, 2001). This chapter investigates the literature to (1) clearly define what constitutes a change order under the contract, (2) identify the different types of change orders, (3) highlight the main causes and effects of change orders, (4) pinpoint the different types of claims associated with change orders, (5) deduce the elements of a successful claim and (6) specify the different quantification methods that have been used to quantify cumulative impact and global claims.

2.2 Change Orders:

2.2.1 Definition:

The below table enumerates the different definitions of change orders in construction contracts.

Table 1: Definition of Change Order

No.	Definition(s)	References
1	"A change order is defined as a written order, agreed upon by the employer, the designer, and the contractor, authorizing changes to the scope of works, the contract time, and the contract price" (AIA 2007a; ConsensusDocs 2011).	Syal, M., and Bora, M. (2016). "Change Order Clauses in Standard Contract Documents." Practice Periodical on Structural Design and Construction, 21(2), 04015021
2	"A change order is a written order issued during contract execution to the contractor by the employer and/or its authorized representative, authorizing a change to the original scope of work which might ensue a decrease or increase to the time for completion and/or to the contract price."	El-Adaway, I., Fawzy, S., Allard, T., and Runnels, A. (2016). "Change Order Provisions under National and International Standard Forms of Contract." Journal of Legal Affairs and Dispute Resolution in Engineering and Construction, 8(3), 03716001.
3	"The definition of a change order in ConsensusDocs is "a written order signed by the employer and the contractor...indicating changes in the scope of the Work, the Contract Price or Contract Time, including substitutions proposed by the contractor and accepted by the employer" as provided in paragraph 2.4.3."	El-Adaway, I., Fawzy, S., Allard, T., and Runnels, A. (2016). "Change Order Provisions under National and International Standard Forms of Contract." Journal of Legal Affairs and Dispute Resolution in Engineering and Construction, 8(3), 03716001.
4	"Change order is defined as "a document recommended by [the] Engineer which is signed by [the] contractor and [the] employer and authorizes an addition, deletion, or revision in the Work or an adjustment in the Contract Price or the Contract Times" (EJCDC 2007)."	EJCDC (Engineers Joint Contract Document Committee). (2007b). C-700—Standard general conditions of the construction contract, ASCE, Reston, VA.
5	"Clause 1.1.6.9 defines a variation as "any change to the Works, which is instructed or approved as a variation under Clause 13"." (FIDIC 1999).	El-Adaway, I., Fawzy, S., Allard, T., and Runnels, A. (2016). "Change Order Provisions under National and International Standard Forms of Contract." Journal of Legal Affairs and Dispute Resolution in Engineering and Construction, 8(3), 03716001.
6	● Change orders entail additional works which are beyond what was anticipated in the contract and which might result in extra cost and time (Civitello, 1987). ● A change order can be defined as written approved authorization for contractors to change from the original plan, specifications, contract, or related documents (R. S. Means, 1991).	Chen, J. (2003). Litigation prediction model for construction disputes caused by change orders (Order No. 3089682). Available from ProQuest Dissertations & Theses Global. (305284372). Retrieved fromhttps://search-proquest com.ezproxy.aub.edu.lb/dissertations-theses/litigation-prediction-model-construction disputes/docview/305284372/se-2?accountid=8555
7	Change orders are considered to be any addition, deletion, or revision to the general scope of the contract that cause an adjustment to the contract price or time for completion (Ibbs 1994)	Ibbs, C. W. (1994). "Project change management." Construction Industry Institute Special Publication 43-1, Austin, Tex.
8	Project change can be defined to be "any action, incidence, or condition that makes differences to an original plan or what the original plan is reasonably based on" (Lee, 2002)	Lee, S. (2007). Understanding and Quantifying the Impact of Changes on Construction Labor Productivity: Integration of Productivity Factors and Quantification Methods. PhD dissertation, UC Berkeley.

2.2.2 Types of Change Orders:

Many types of change orders exist in the construction industry. According to research, the major types of change orders are:

2.2.2.1 Employer acknowledged change:

This is the most common type of change orders in construction projects. It generally presents the least conflict knowing that it is incorporated into the employer's budget and all parties agree that the instructed change constitutes a variation under the contract. The only remaining thing to do is to quantify the time and cost impact of the introduced change (Hanna and Swanson, 2007). The value of the total change order cost impact often encompass the (1) costs of actual work performed, (2) costs related to any change in method, (3) costs related to the effect of changed work on contract work, (4) other interferences or impact costs (delay, acceleration, etc.) (Civitello, 1987).

2.2.2.2 Constructive Change:

A constructive change is one in which the employer perceives that the change forms part of the contract; however, the contractor views the same as an increase in its scope of work (Hanna and Swanson, 2007). The employer and/or its representative assert that the change is called for under the contract. Accordingly, the contractor shall proceed with the execution of the instructed changes but submit a claim in accordance with the timeframe and conditions set forth in the contract in order to reserve its right to collect compensation for the disputed work (Lee, 2002; Sweet 1985).

McNeill Stokes identified common types of constructive changes that include, but is not limited to the following:

- Defective Specifications
- Modifications in methods statements and method of performance
- Rejection of “or equal” material submittals
- Defective employer-furnished property
- Stringent over inspection
- Misinterpretation of contract conditions or specifications

2.2.2.3 Consequential Change:

Consequential changes are similar to constructive changes. They differ by the fact that they are changes ensuing and/or necessitated as a direct result of a previous change order. Consequential changes are a result of a domino effect or domino relationship of cause and effect (Civitello 1987; Lee, 2002).

2.2.2.4 Bilateral Changes:

Bilateral changes are mutually agreed upon changes executed by the employer and contractor. The contracting parties agree that specified additional work will be executed in return of agreed upon time and cost impact. Bilateral change orders are used to negotiate equitable adjustments resulting from the issued change order and reflect other agreements of the parties modifying the terms of a contract (Sullivan, 2004).

2.2.2.5 Minor Changes:

Minor changes are changes introduced in reply to drawings or minor modifications to required specifications. These changes are consistent with the intent of the contract documents and are considered by the employer or its representative as minor changes that do not ensue any implications to the contract price or contemplated completion date (Sweet, 2000). If the contractor considers that such change entails any cost or time implications, it shall submit a claim in accordance with the conditions of contract to reserve its right to recover any resultant time or cost.

2.2.2.6 Cardinal Change:

The definition of a cardinal change is detailed under Section 5.1 of this research. This section enumerates the different definitions of cardinal change extracted from the literature and classifies what qualifies to be considered as a cardinal change.

2.2.3 Causes of Change Orders:

Change orders are generally issued to instruct variations to the contemplated scope of work and to cover design errors and/or material quantities. Changes are a result of numerous causes that might be attributed to the different parties of the contract. Notwithstanding, there are numerous reasons that might trigger the issuance of change orders or might ensue a variation under the contract. Identifying the causes of change orders is crucial for construction projects in order to mitigate potential changes in future projects and to minimize the implications of the same (Khalifa and Mahamid, 2019).

The major causes of change orders in construction projects include but not limited to the below:

- Defective drawings and specifications
- Lack of proper design coordination
- Incomplete and defective design
- Legal restrictions and newly laid down regulations
- Employer’s additional requirements and works
- Defective or poor workmanship

- Employer’s financial hardship and difficulties
- Safety considerations
- Change in schedule and planned sequence of activities
- Differing site conditions
- Weather conditions

(Civitello, 1987; Ibbs and Allen, 1995; Assaf and Al-Hejji, 2006; Khalifa and Mahamid, 2019)

According to a study conducted by Kean Et al. (2010), major causes of change orders have been surveyed and grouped based on contracting parties; the latter are delineated under Table 2 below. To indicate a non-party related group, an additional group named “other variations” has been established.

Table 2: Causes of Change Orders (Keane Et al., 2010)

Owner-related variations	Consultant-related variations	Contractor-related variations	Other variations
Change of plans or scope (CII 1990b)	Change in design (Arain et al. 2004; Fisk 1997)	Lack of involvement in design (Arain et al. 2004)	Weather conditions (Fisk 1997; O'Brien 1998)
Insufficient planning at the project definition stage, or lack of involvement of the owner in the design phase (Arain et al. 2004)	Errors and omissions (Arain et al. 2004)	Unavailability of equipment (O'Brien 1998)	Safety considerations (Clough and Sears 1994)
Owners' financial problems (Clough and Sears 1994; O'Brien 1998)	Conflicts among contract documents (CII 1986)	Skills shortage (Arain et al. 2004)	Change in economic conditions (Fisk 1997)
Inadequate project objectives (Ibbs and Allen 1995)	Technology change (CII 1994b)	Financial problems (Thomas and Napolitan 1995)	Sociocultural factors (O'Brien 1998)
Replacement of materials/ procedures (Chappell and Willis 1996)	Value engineering (Dell'Isola 1982)	Desired profitability (O'Brien 1998);	Unforeseen problems (Clough and Sears 1994; O'Brien 1998)
Impediment of prompt decision-making process (Sanvido et al. 1997; Gray and Hughes 2001)	Poor coordination (Arain et al. 2004)	Differing site conditions; poor workmanship (Fisk 1997; O'Brien 1998)	
Obstinate nature of owner (Wang 2000; Arain et al. 2004)	Design complexity (Arain et al. 2004; Fisk 1997)	Fast-track construction (Fisk 1997)	
Change in specifications by owner (O'Brien 1998)	Poor working drawing details (Geok 2002; Arain et al. 2004)	Poor procurement process (Fisk 1997)	
	Poor knowledge of available materials (Geok 2002)	Lack of communication (Arain et al. 2004)	
	Lack of required data (Arain 2002)	Lack of experience	
	Ambiguous design details (O'Brien 1998)	Long-lead procurement (Fisk 1997)	
	Poor design (CII 1990a; Fisk 1997)	Complex design and technology (Arain 2002)	
	Change in specifications (O'Brien 1998)	Lack of strategic planning (Clough and Sears 1994)	

2.2.4 Process for Initiation, Review, and Approval of Change Orders

Figure 3 delineates one a common process for the initiation, review, approval of issues change orders.

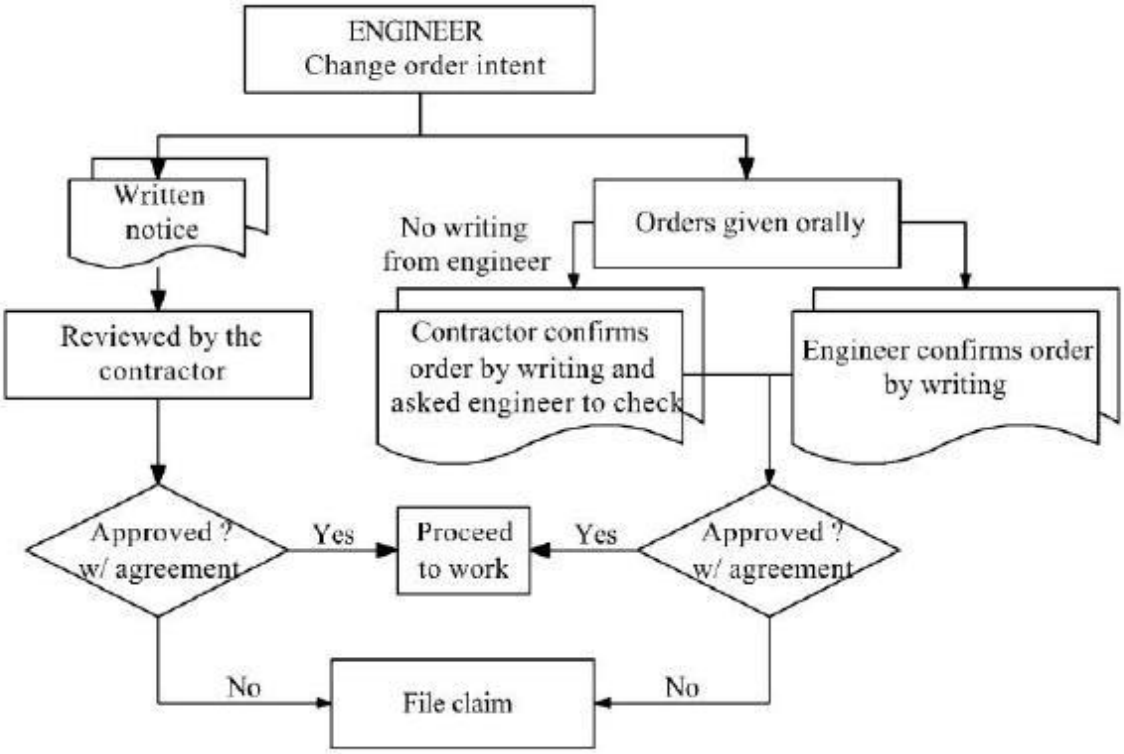

Figure 3: Summary of Initiation of Change Order by Hadikusumo, (2003)

2.2.5 Effect of Change Orders on Construction Projects:

Changes and variations to the works have been regarded as one of the major causes of delay, disruption, cost overruns, and disputes between the contracting parties (Motawa et al. 2007).

Based on the literature review findings, the effects of change orders and variations on construction projects can be grouped into five main categories:

2.2.5.1 Quality related effects:

Variations during the project lifecycle can have a direct impact on the quality of the works (CII, 1994). High number of variations can affect the contemplated completion time and the desired quality; especially in cases whereby the contractor attempts to accelerate the construction process.

2.2.5.2 Time related effects:

Variations during the project timeline might lead to disruption of progress and ensue delays to the contemplated time for completion (CII, 1990a). Moreover, most contract conditions between contractors and subcontractors are on a back-to-back basis; the contractor will not be able to pay its subcontractors for varied works, unless or until the former has been paid by the employer. According to the aforementioned, the subcontractors' rate of progress might decrease thus resulting in delays to the completion of the works (CII, 1994a). Logistic delays might also occur due to change orders and variations that require new equipment and material (Fisk, 1997).

The resulting schedule delay is regarded as the difference between the estimated duration (baseline duration subject to granted extension of time) and the actual duration of the project (Chen, 2015).

2.2.5.3 Cost Overrun and Cost Inefficiency:

Variations in construction projects can lead to rework and demolition (Clough and Sears, 1994; CII 1990). Additionally, delay in payments might occur leading to additional financing costs on behalf of the contractor due to an increase in interest rates. Notwithstanding, variations also require different processing procedures, documentation, paper work, reviews, engineering works and on-site supervision leading to increased overhead expenses (O'Brien, 1998). Accordingly, variations are considered to be a source of additional work on behalf of the contractor which might sometimes affect the contractor's profitability on the project (O'Brien, 1998).

In project management, closely tracking the project's actual budget and comparing it with the initial baseline budget is a crucial performance indicator of the project's success level. Poor performance can be either a result of cost overrun or cost inefficiency (i.e. cost loss). Cost overrun can be considered as the additional costs directly attributed to positive projects changes. The part of cost overrun that excludes the direct impact of project changes is a better representative of cost inefficiency. Change-exclusive cost inefficiency represents the part in cost deviations that cannot be directly explained by change orders. Cost inefficiency can be a result of poor management, bidding shortcomings, and/or indirect effect of change orders such as the cumulative impact of change orders (Chen, 2015).

Many studies managed to quantify cost overrun by calculating the difference between the project actual cost and the project baseline budget. However, ignoring project change while studying and analyzing project cost overrun can certainly lead to misleading and inaccurate results. The below figure provides an overview of the dynamics of project costs by delineating the difference the project's initial baseline budget and the actual costs incurred (Chen, 2015).

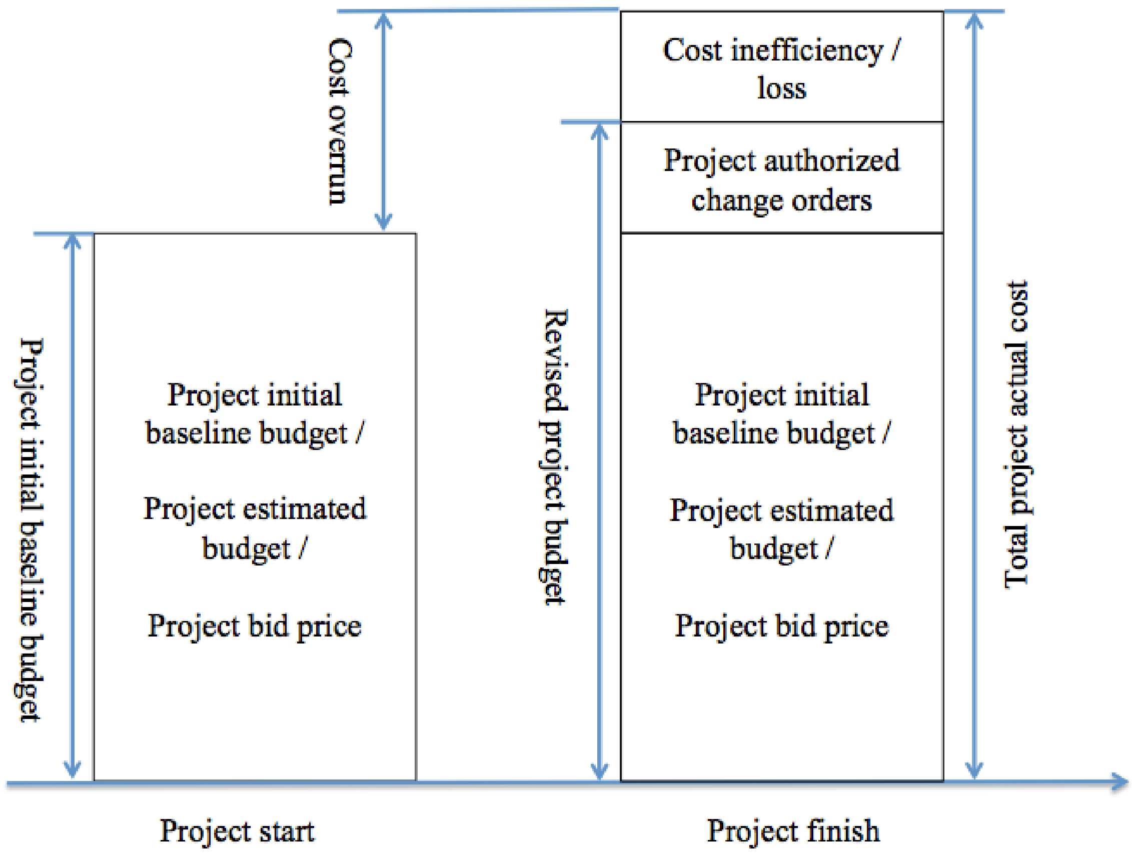

Figure 4: Project Change and Cost Overrun (Chen, 2015)

2.2.5.4 Organization related effects:

Variations are often the major cause of project disputes in construction projects. Disputes over the implications of change orders and variation clauses are often inevitable (CII, 1986; Fisk, 1997). Accordingly, these disputes might affect the professional relations between the contracting parties and create an atmosphere of negativity. In addition, variations may require or impose additional safety methods and procedures knowing that acceleration to the works might result in poor safety conditions and an increase in accident rates (O'Brien, 1998). Accordingly, the effects of change orders and variations might result in tarnishing a firm's reputation if the contractor was delayed in accomplishing the works on time, failed to meet the quality requirements and specifications, suffered from accidents due to poor safety conditions, and/or caused professional disputes that debilitated professional relationship with other parties.

2.2.5.5 Other effects:

Large number of variations can directly affect labor productivity and cause significant disruptions to the work (Thomas and Napolitan, 1995; Hanna et al., 1999, 2002a). Additionally, large number of variations orders might lead to excessive material waste. Adverse time effects might be compensated by acceleration techniques or the use of floats.

2.2.6 Change Order Provisions under National and International Standard Forms of Contract:

El-adaway et al. (2016) conducted an analysis for studying change order provisions under national and international standard forms of contracts including those published by: the Engineers Joint Contract Documents Committee (EJCDC), ConsensusDocs, American Institute of Architects (AIA), International Federation of Consulting Engineers (FIDIC), New Engineering Contract (NEC), the Joint Contracts Tribunal (JCT) and the World Bank. The analysis involved three dimensions that included reviewing change order provisions in relation to execution and procedures, power and authority and adjustments to contract completion time and contract sum. The study aimed at assisting the contracting parties to better manage and acknowledge their rights and responsibilities while handling variation orders. The rights and responsibilities of each party to the contract – under the different standard form of contracts – was summarized vide Table 4.

Similarly, Syal and Bora (2016) conducted a comparative review of change-order-related clauses under the different standard form of contracts. The study highlighted the impact of these provisions on the change orders pricing and procedures. Change-order-related provisions in standard contract documents and the procedures for processing change orders are summarized under Tables 3, 4 and 5.

Table 3: Rights and Responsibilites of the Different Contracting Parties during Change Orders under Different Standard Forms of Contract (El-adaway et al., 2016)

Contract	Owner/employer	Engineer/project manager/architect/administrator	Contractor
AIA	Requests changes and signs change orders or construction change directives	Evaluates, writes, issues, and signs a change order or construction change directive	Carries out work
	Must approve any change or adjustment	Issues and signs order for minor changes in the work	May dispute adjustments Keeps itemized accounts
ConsensusDocs	Orders and writes a change order or interim directed change	No identified contractual relationship between architect/engineer and contractor	Carries out work
	Negotiates adjustments		May propose a change to owner Negotiates adjustments Provides estimate for cost of disputed work
EJCDC	Authorizes change orders and work change directives	Recommends, writes, and issues a change order or work change directive	Carries out work
	Negotiates adjustments	Issues field order	May change the work in emergency or as provided in paragraph 13.14.D
		Negotiates adjustments	Negotiates adjustments
FIDIC 4th	Consults with engineer and contractor over changes in prices	Issues variations Agrees on suitable rates and prices with the contractor, after due consultation with the employer and the contractor Fixes rates or prices if parties do not reach agreement	Carries out work Consults with engineer and employer over changes in prices
FIDIC 99	Approves variation if provided in the particular conditions as per subclause 3.1	Issues variations Each variation shall be evaluated in accordance with clause 12, unless the engineer instructs or approves otherwise in accordance with subclause 13.3 Resolves disagreements	Carries out work May propose a variation to the engineer
World Bank	Approves variations as per subclause 3.1	See FIDIC 99	See FIDIC 99
JCT	May dispute adjustments	Approves and issues variations Reviews variation quotations May appoint a quantity surveyor to resolve quotation disputes	Carries out work May dispute adjustments Provides variation quotation Notifies architect/contract administrator of delay
NEC	May dispute adjustments to prices and times	Instructs a change to the work Reviews quotations by contractor	Carries out work Notifies project manager of a compensation event
		Assesses compensation events	Submits quotations May dispute adjustments

Table 4: Change-Order-Related Provisions in Standard Contract Documents (Syal and Bora, 2016)

Contract document	Type	Article/part
	Owner and General Contractor Agreements (Prime Contracts)	
AIA A201-2007	General conditions	Article 7
ConsensusDocs 200	Standard agreement and general conditions	Article 8
EJCDC C-700	General conditions	Articles 10,11,12
CDCC 2-2008	Stipulated price contract	GC Part 6
	General Contractor and Subcontractor Agreements (Subcontracts)	
AIA A401-2007	Standard agreement	Article 5
ConsensusDocs 750	Standard agreement	Article 7
EJCDC C-523	Construction subcontract	Articles 9
CCA 1-2008	Stipulated price contract	SCC Part 6

Table 5: Procedures for Processing Change Orders in Prime Contracts (Syal and Bora, 2016)

Agreement and version	AIA A201-2007	ConsensusDocs 200	EJCDC C-700	CCDC 2-2008
Agreement and General Conditions	Owner and Contractor	Owner and Contractor	Owner and Contractor	Owner and Contractor
Written form when price and time extension are agreed upon	Change Order	Change Order	Change Order	Change Order
Written form when price and time extension are not agreed upon	Construction Change Directive	Interim Change Directive	Work Change Directive	Change Directive
Written authorization required	7.2.1	8.1.3	10.01.A	6.2.1
Contractor must proceed without agreement on price or time	7.3.1	8.3.3	10.01.A	6.3.1
Third-party decision maker	Architect	Article 12: Dispute Mitigation and Resolution	Engineer	Consultant
Initial payment, if not agreed upon in the change order	7.3.9: Architect determines progress payments	8.2.2: Owner pays 50% of estimated price	10.05: Claims must be submitted to engineer	6.3.1.1: Progress payments based on cost and contractor's fees

Evidently, there are numerous differences between the various standard forms of contract in relation to the roles and rights of each contracting party in managing change orders with regards to the processing procedures of change orders. This opens the window for a very critical research topic which tend to indicate and investigate the strengths and weaknesses of each standard form of contract in managing change orders.

2.2.7 Project Change Management

Project management is defined as the application of skills, tools, knowledge, and techniques to achieve project success and to meet all project requirements. Change management is an essential component of effective project management (Chen, 2015).

Change management is defined as the process of rejecting or approving changes, managing changes to contract documents and deliverables, reviewing change requests, managing changes to project management plans (PMI, 2013). The proposed system helps mitigate the impact and risks associated with change orders knowing that the system allows to document all changes in an integrated fashion. Some of the key features the subject change management system include:

- Conducting change management from project inception until completion; this can be considered within the ultimate responsibilities of the project manager.
- Officially recording all change requests even those that were communicated verbally.
- Approving or rejecting documented change requests to be conducted by a responsible individual, usually the project manager, project sponsor, or a change control board. The change control board (CCB), if any, is a chartered group responsible for the evaluation, review, approval, or rejection of changes to the project and for communicating and recording the latter.
- Requiring new or revised cost estimates/valuations, sequencing of activities, resource requirements, and analysis of risk response.

According to Voropajev (1998), change management is an integral process directly related to all internal and external factors of the project which, in terms, influence project changes. Change management is also a process to forecast potential changes, to coordinate changes across the whole project, and to plan preventative impacts.

Improving project change management can ensue significant savings in the total cost of construction projects (Ibbs, 1994). A research conducted by Ibbs (1994) identified five key principles to achieve effective change management which include promoting a balanced culture for change, recognizing and evaluating changes and leveraging lessons learned. In accordance with these principles, a prototype has been developed along with recommended change management practices for each phase of the prototype.

In 2001, Ibbs et al. revisited the proposed change management system. The proposed framework highlighted the fact that the core idea of any system shall be to anticipate, recognize, evaluate, document, resolve and learn from all conflicts and previous lessons to maintain and support the viability of the project. By applying the proposed framework and implementing the project change management system, all parties to the contract can effectively minimize disadvantageous and deleterious changes and help promote more beneficial changes.

Pena-Mora and Park in 2003, introduced a dynamic system model – based change control and planning tool which incorporates different behavioral patterns of construction change, along with the devised equations and structure of the subject model. It was suggested that the model-based approach is effective in advancing project change management systems.

Motawa et al. (2007) highlighted that many elements of the project processes shall be considered in the development of change management systems that shall address all external and internal factors that may influence project changes. The latter established a change management system that integrated a fuzzy logic-based prediction model and a system dynamics model (DPM: Dynamic Planning and control Methodology). The fuzzy logic-based prediction model helps in predicting the probability of change occurrence by analyzing and studying available project information at early stages of the project. On the other hand, the system dynamics model is developed to quantify and evaluate the impact of introduced changes on the project performance.

2.2.7.1 Project Change Prediction Analysis

In any project change management system, an essential but often missing component, is proactive change management. Proactive change prediction is difficult and complex knowing that the causes of change orders are greatly varied (Hseih et al., 2004). A comprehensive analysis incorporating existing project data and various aspects throughout the overall project value chain is needed for a nearly accurate prediction of project change.

Hseih et al. (2004) analyzed the different causes of change orders in Taiwan public work projects. It was found that a 10 % to 17% ratio of change orders to total project costs was typical in Taiwan's metropolitan public projects. The highest percentage of change orders was attributed to shortcomings and problems in design and planning.

Wu et al. (2005) utilized statistical analysis on a number of case studies to identify the different causes for design change. They found that effective site surveys, and extensive planning and design throughout the whole project life cycle is essential in order to minimize design changes.

Anastasopoulos et al. (2010) used a variety of count-modeling methods including the Poisson, negative binomial, and the zero-inflated Poisson, to analyze the frequency of change orders in order to form a better understanding of the factors associated with these frequencies. They assessed the influence of the contract type, project duration, project cost, and project type on the frequency of issuance of change orders. Contract price and contract duration were found to be major significant factors associated with the frequency of change orders in manner that is not linear; for large projects incremental increases in the contract amount result in minor changes to change order frequency; for small projects, incremental increases in in contract amount result in steep increases in the frequency of change orders.

Ibbs (2002) quantified change patterns by conducting a series of statistical analyses. Projects that experience changes are susceptible to a worsened cost and schedule performance compared to the budgeted performance. Productivity and its predictability largely deteriorates with the increasing amount of change orders.

2.2.8 Avoidance of Variations

The contractual right to vary the works shall be exercised in due skill and care. If the contract is governed by common law, this right is given to the engineer as a way to safeguard the employer's entitlement to resulting delay damages. In case the employer interfered and caused delays and disruptions to the works that prevented the contactor from complying with the contemplated time for completion, the time for completion will be considered to be "at large" prohibiting the employer from its rights to levy delay damages. In civil law, the “time at large” concept is not considered as a common concept; however, civil law construction contracts provide for change-order and variation clauses. The rational and aim behind variation clauses is to provide the employer with the right and power to adjust the scope of works. (Furst and Ramsley, 2006; Totterdill, 2006; Wendtland, 2008).

Accordingly, the variation clause generally grants the employer/engineer the unilateral freedom to issue a variation under the contract. Unfortunately, most issued change orders/variations include deficiencies, are ill-conceived, and/or are poorly prepared. The precise content of every variation shall vary depending on the type of works and the desired intent of issuing such a variation.

In order to avoid variation orders, it is very important to carefully and meticulously study the projects specifications, bill of quantities, design drawings, quality requirements, rates, and other contract documents in order to clearly define the scope of work and make sure that latter serve the intent of the project. Unambiguous and clear contract documents are vital to limit the need to issue variations to the works. Method requirements, testing requirements, cooperation requirements, and interface requirements can be clearly determined and specified within the contract documents in order to avoid the burden of having to instruct variations in relation thereto. (Lewison, 2004; Ramsley, 2006; Totterdill, 2006; Wendtland, 2008).

2.3 Construction Contract Claims

With the development and introduction of advanced technologies, new standards, and employer-instructed changes and variations, construction projects are becoming more and more complex. Conflicting opinions may erupt between the concerned parties in respect to different aspects of design and construction. This increasing complexity of construction projects, has been resulting in higher possibilities of adversarial attitudes, disputes, and conflicting interpretations (Abdul-Malak et al. 2002).

In the construction industry, the contract documents define all the rights and obligations of the contracting parties and all procedures pertaining to the agreement entered there into. A claim can be defined as a request forwarded by the contractor for additional cost and/or an extension of time for the time for completion of the project which may evolve into a dispute that may or may not be amicably resolved by the parties to the contract (Jervis and Levin 1988; Barrie and Paulson 1992). In light of the above, it has been almost inevitable, in every construction project, to incur significant additional costs by the employer, the contractor, or both due to the action of parties involved or action of the other party.

Claims and disputes often arise from a number of cases including and not limited to increase in scope of work, defective specifications, restricted access to site, interpretation of site instructions, differing site conditions, and disagreement to what constitutes substantial completion of the works (Abdul-Malak et al. 2002).

2.3.1 Types of Claims

2.3.1.1 Claims for Extension of Time

Considerable number of events can result in the delay and disruption of the works giving rise to extension of time claims. Standard forms of contract generally include provisions for extension of time. These clauses discharge the contractor from being held liable of “excusable delays” that might be as a result of the aforementioned cases. The contractor shall, upon experiencing a delay that the latter believes that is beyond its responsibilities and/or liability, serve a notice for extension of time in line with the prevailing contract conditions (Thomas, 1993; Jaeger and Hok, 2010).

Thomas (1993) identified the major obstacles that may hinder the prompt settlement of extension of time claims are:

- Assumptions that such claims are automatically linked with additional payment.
- Late or lack of serving a proper notice in line with the contract stipulations.
- Failure to recognize the delay at the proper time and to maintain contemporary records to prove and quantify same.
- Failure to regularly update the programme of works that can allow the contractor to closely track the progress on site and quantify the impact of delays on the time for completion.
- Pressure exercised by the employer to complete the works in time irrespective of any delay experienced by the contractor.
- Insistence on behalf of the employer or its personnel that unreasonably detailed critical paths shall be furnished to be able to assess the effects of delays.
- Poor presentation and substantiation of the submitted claim.

In order to effectively prepare a detailed extension of time claim, the contractor shall maintain regular and accurate programme updates, daily job logs, progress reports and detailed contemporary records documenting progress, material, personnel and ongoing activities. The latter are essential to be able to quantify any delay and foresee its effects on the progress of the works. In addition, the contractor can also support its claim with pictures and videos (Thomas, 1993).

Rightful extension of time claims are considered to be win-win situation for the contracting parties knowing that it relief the contractor from liability for delay damages (liquidated damages) and establishes a new time for completion thus preventing the time to become at large (SCL protocol, 2002).

2.3.1.2 Claims for Additional Payment due to Prolongation

While an award of an extension of time will disallow the employer to levy delay damages, such an award does not necessarily carry an entitlement to any additional prolongation costs that may be accompanied or be a result of the experience delays.

Qualifying delays that affect the critical path are usually supported with a claim for prolongation costs for the period of delay (if such delays are accompanied with matters that may give rise to additional prolongations costs) (Thomas, 1993; Hewitt, 2016).

It is common practice between contractors to link prolongation cost claims and extension of time claims and submit them as one single claim knowing that generally both costs arise from the same events. Considerations must also be given to dealing with these two subjects separately in light of the fact that the award of extension of time is relatively easier to deal with and to determine compared to additional payment claims (Hewitt, 2016).

Regular head of claims associated with prolongation cost claims are:

- Site overheads and preliminaries
- Prolongation costs of affected activities
- Head office overheads

- Loss of Profit (if allowed for in the contract conditions)
- Adjustment for overheads and profit accounted for in variations
- Adjustments for non-recoverable delays
- Concurrent delays
- Delayed release of retention

2.3.1.3 Disruption and Loss of Productivity Claims

In this type of claim, the contractor shall establish that a planned orderly timing of activities and sequence of events has been affected by causes solely attributed to the employer/engineer or that are within the latter's control. It would be necessary to prove that the contractor has incurred delays to a certain activity and/or to the time for completion of the works due to disruption caused by the employer or its personnel (Thomas, 1993; Jaeger and Hok, 2010).

Many disruption claims fail as a result of the contractor's inability to prove that the additional costs incurred are a result of matters for which the employer/engineer are responsible. In some cases, it may be possible to compare actual productivity during the disruption period to the original productivity prior to the disruption event.

2.3.1.4 Acceleration Claim

In the event of a delay or disruption, the contractor and the employer may reach a consensus to accelerate the progress of the works. One case would be that the employer prevailed upon the contractor to mitigate the incurred delays cause by the employer or sometimes to complete the works prior to the contemplated time for completion provided for in the contract. In such circumstances, the contractor will be entitled to additional costs as a result of complying with the above. The contractor will be entitled for payment for the following:

- Overtime payments resulting from extended working hours.
- Additional mobilization and demobilization costs resulting from the increased number of labor and plant.
- Additional labor and plant costs resulting from loss of efficiency due to many work faces operating simultaneously.
- Loss of productivity costs resulting in working out of sequence and/or on more than the optimum number of work faces.

(Thomas, 1993; Jaeger and Hok, 2010; Hewitt, 2016)

2.3.1.5 Damages under Law Claim

Standard form of contracts include special circumstances that entitle the contractor to submit a claim for additional cost or time. In the case of circumstances arising from or falling outside those specified in the contract, the contractor can opt to make a claim for damages under the prevailing law especially in case of prevention (Hewitt, 2016).

Among other cases, is the case whereby the employer/engineer were aware of a certain circumstance, but failed to disclose and/or misrepresented the existence of such condition to the contractor. In such a case, the employer may be liable under the law for damages resulting from its failure to disclose superior knowledge (Jaeger and Hok, 2010).

2.3.1.6 Claims for Variations

Most standard forms of contract give the employer/engineer the right to issue instructions and change the nature of the work and most will specifically prohibit the contractor from proceeding with the works related to any variation until and unless a written instruction was given. Moreover, most standard forms of contract contain specific provisions to deal with variations and to specify all related procedures. If these provisions were adhered to, there would be no reason to submit a claim because the entitlement to additional payment will already be acknowledged (Hewitt, 2016).

In reality, instructions for variations may not be issued in a formal manner and may not adhere to the procedures set forth in the contract. Contractually, the contractor, in order to reserve its right for proper compensation, tends to submit a claim to preserve its right to additional payment or extension of time for an instruction which he considers to comprise a variation under the contract but which has not been approved or instructed as a variation order (Thomas, 1993).

In addition to the above, it is common that the rates applicable in the contract must be used to quantify the costs associated with every variation; however, sometimes the contractor might incur additional indirect costs that are subject to claims (Jaeger and Hok, 2010).

Common factors that affect the valuation of variations are:

- Changed quantities.
- Changed conditions and circumstances.
- Time-related costs.
- Changed timings.

2.3.2 Elements of a Successful Claim

The object of any claim is to proof and demonstrate that the claimant is entitled to the substantiated amount of compensation (additional time or additional money or both). The claim must be supported with detailed particulars and justified. Hewitt (2016) identified the elements that are essential to include in every claim to increase the likelihood of its success. These elements are as follows:

- Cause
- Effect
- Entitlement
- Substantiation

Many rightful claims were not successful because they lacked part or all of the above essentials.

2.3.2.1 Cause

The cause is the event that gives rise to a claim including and not limited to the following:

- Late or restricted access to site.
- Issuance of revised drawings.
- Issuance of instructions that constitute additional works and variations.
- Exceptionally adverse climatic conditions.
- Issuance of instructions to accelerated the works or any part thereof.
- Changes in governmental and local legislations.
- Force majeure.

- Delays caused by the employer or its personnel and/or other parties engaged by the latter.
- An act of prevention by the employer or any of its agents under the contract.

2.3.2.2 Effect

For any claim to be successful, the claimant must be able to demonstrate the effect of such a claim by linking the cause of the claim to the effect.

2.3.2.2.1 Time Considerations

- What is the effect of the delay on the programme of works?
- Will the delay impact the contemplated date for completion of the works?
- Will the event result in a delay because of changed or additional instructed works?
- Will the event require any acceleration and/or delay mitigation measures?
- Does the event allow the contractor to claim for an extension of time under the contract provisions?

2.3.2.2.2 Financial Considerations

- Will the delay result in incurring additional prolongations costs on behalf of the contractor?
- Will compliance with a new instruction result in abortive works and/or rework?
- Is the contract a lump sum or a re-measurable contract? How will any adjustment to the contract price be made?

- If mitigation measures or acceleration were required, what will be the associated costs with such measures?
- Does the contract provisions allow the contractor to recover costs from the occurrence of the event giving rise to claim?

2.3.2.3 Entitlement

Proving the cause and effect does not necessarily prove entitlement under the contract. The contractor shall respect and prove that the claim flows from a remedy contained under the contract conditions, and/or from a breach giving rise to damages under the prevailing law. It is very crucial to clearly set out the contractual basis of the claim.

A substantial part of any contract is risk allocation between the parties to the contract. The contract shall demonstrate that the event giving rise to claim is a subject provided for under the contract or under the prevailing law (Hewitt, 2016).

2.3.2.4 Substantiation

The last crucial element of any claim is substantiation. In other words, proving that all statements made, calculations submitted, and incurred losses are correct. It is essential that every claim contains levels of evidence that can be obtained by keeping contemporary records and data (Hewitt, 2016).

2.4 Quantification Methods Used for Cumulative Impact and Global Claims

2.4.1 Cumulative Impact Claim

To prove resultant injury in cumulative impact claims, the contractor claims loss of productivity as highlighted here above. Contractors try to relate the loss of productivity and efficiency to cost overrun and unanticipated delays to the completion of the works. One of the biggest challenges for contractors while attempting to pursue a cumulative impact claim, is the ability to prove resultant injury knowing that it is solidly linked to causation. In one case, the court rejected the Contractor's claim because of its inability to prove resultant injury stating: "there is no evidence of what the impact was, how it impacted the work, or at what cost to the contractor" (Coates Industrial Piping, Inc.,). Many studies aiming at quantifying the cumulative impact employ advanced statistical analysis techniques and artificial intelligence (Lee, 2007).

Notwithstanding, relying blindly on such techniques, studies, and models is dangerous. The contractor shall make sure that the used data is reliable along with the procedures used to analyze and process the same (Lee, 2007). In fact, there have been minimal studies to gather and analyze the different quantification methods that can be employed by contractors to quantify the cumulative impact. These efforts include Thomas and Smith (1990), Schwartzkopf (1995), Cole and Harmon (2006), and Lee (2007).

2.4.1.1 Traditional Methods

Traditional methods that have been frequently used by contractors include the total cost method, modified total cost method, jury verdict method and measured mile analysis. These methods have been criticized by courts in terms of reliability and accuracy.

Amongst the above, the measured mile approach has been preferred to be used by courts and boards. However, the latter also has many shortcomings that shall be addressed.

2.4.1.1.1 Total Cost Method

In calculating cumulative impact of claims, the most common and basic method that has been used by contractors is the total cost method. Under this method, the contractor simply opts to subtract the estimated costs (bidding costs) for the project from the actual incurred costs. Contractors generally rely on this method when they cannot support their claim with detailed documentation and detailed particulars proving damages. Although courts have been very reluctant and skeptical regarding the use of this method, they have allowed contractors to recover its incurred costs on the theory that "the very factors that produce loss of productivity can also serve to preclude the accurate and precise record-keeping" (Shea, 1989). For instance, in Atlas Construction Co. v. United States, the board accepted the application of this method to award the contractor damages pertaining to labor inefficiency. In Atlas Construction Co. v. United States, the government has issued a substantial number of changes and design variations. The court accordingly rejected the government's stance that the contractor has failed to prove causation and resultant injury by applying the total cost method.

Notwithstanding, the total cost method is not favored by courts because of its failure to eliminate the factors and events for which the defendant is not liable for. It simply assumes that all the incurred losses are for reasons directly attributed to the defendant. In Centex Bateson Constr. Co. v. West, 250 F.3d 761 (2000), the court declared that for the total cost method to be considered the contractor may be required to establish: (1) the impracticability of proving actual losses directly, (2) the reasonableness if its bid, (3) the reasonableness of its actual cost, (4) and the lack of responsibility for the added costs. In this case, the contractor was denied to recover losses since it could not prove the reasonableness of its bid.

Thus, one downside of the total cost approach, is that the employer can simply attempt to defeat the contractor's claim by proving the existence of overruns and disruptions that are cause by the contractor without allowing any real ability of apportionment of losses between the employer and the contractor. This method assumes that, if not for the defendant, the claimant would have been able to complete the works within its allocated budget and on time. In this vein, the two major shortcomings accompanied with this method is the assumption that the contractor's bid is reasonable and that it fails to consider disruptions and inefficiencies caused by the contractor.

Despite the method's disfavor, some courts have accepted the use of this method on the basis of a state law standard for proving contract damages similar to Marta v. Green International Inc. whereby the court awarded the contractor $2.8 Million for increased performance costs due to the employer's failure to properly administer the contract noting that: "if a plaintiff can show with reasonable certainty the total amount of damages and the degree to which those damages are attributable to defendant, that is sufficient to support an award". Therefore, under the laws of the state of Georgia, all that is required from the contractor is to provide the court with sufficient data to estimate damages with a certain level of certainty. This highlights a crucial fact whereby the acceptance of courts for the application of the total cost method varies between different jurisdictions and states.

2.4.1.1.2 Modified Total Cost Method

The difference between the modified total cost method and the total cost method is that it aims to account for the disruptions and the overruns that are attributed to the contractor. Hence, the contractor attempts to subtract from its actual costs all non-employer related performance factors and disruptions including the costs incurred due to contractor's errors and inefficiencies, and subtract the bid price for the project. Accordingly, this method allows the contractor to arrive at a figure that is more reliable and that reflects a fair estimate of the increased costs directly suffered from particular actions of the employer/engineer. The contractor shall make sure that the adjustments and apportionments of the total cost must be made in respect of any losses which are not caused by defendant in order to avoid overcompensating the claimant. (Shwartzkop, 1992; Hannah and Sullivan, 2004).

2.4.1.1.3 Jury Verdict Method

After determining that causation has been established, this method is applied by courts if the amount of damages cannot be ascertained with certainty. In the Appeal of David J. Tierney, Jr., Inc. GSBCA No. 7107, the board used this method to determine a reasonable amount of damages incurred by the contractor. This approach amounts to nothing more than an educated guess by the court/board based on information available to the "trier-of-fact" (Cohen, 1998). To arrive at a reasonable and fair amount, the jury uses portions of the evidence presented during the hearings (Caplicki III, 2003).

Given the uncertainty of the state of cumulative impact claims, the contractor shall make sure that causation has been established prior to basing its case on the jury verdict approach (Cohen, 1998). According to Caplicki III (2003), the use of this method results in a rather conservative estimate of the lost productivity; thus, despite being a viable method, it is not usually the contractor's first choice.

In the case referred to above, the board was unable to precisely determine the compensable impact, which portions of the works had been impacted, the severity of the impact, and/or which changes had caused this impact. Accordingly, damages were awarded on the project as a whole.

To apply this method a party must be able to prove and present the following:

- A clear proof of resultant injury.
- An indication that there is no other reliable and pragmatic method to compute the incurred damages.
- Evidence of sufficient weight of fact to make a reasonable and educated approximation of the incurred damages.

The defendant, in trying to denounce and defeat the use of this method, can contend that the claimant has failed to meet the burden of demonstrating damages with a reasonable amount of certainty. This allows the court to make a guess regarding the damages incurred and thus release the claimant from its responsibility to prove damages and resultant injury.

2.4.1.1.4 Measured Mile Approach

This method was first introduced by Zink (1986). In comparison to all the above methods, the measured mile approach, is one of the main proven methods in order to quantify the incurred costs and damages once causation and loss of productivity has been established. This method examines retrospectively what the proper “should have been cost” (Clark Concrete Contractors Inc. V. GSA, GSBCA No.14340, 99-1 BCA). This method involves the comparison of the contractor’s productivity during non-impacted periods with those during impacted period of the same area of works. In some cases the contractor might select data available from projects involving similar working conditions and similar type of work (Jones, 2001).

According to Finke (1998), five pre-requisites are necessary to be able to use this method:

- Scope of the disrupted work.
- Un-impacted time period.
- Actual productivity during the un-impacted period.
- Impacted time period.
- Actual productivity during the impacted time period.

This approach can be considered an excellent basis for calculating the extent of damages if a suitable benchmark has been selected (DANAC, Inc., ASBCA No. 33,394, 97-2 BCA).The calculated productivity loss is more accurate than that calculated vide the previous approaches since (1) the comparison is based on the project’s actual productivity data and not a budgeted and desirable productivity (Lee, 2007), (2) any inefficiency attributed to the contractor is considered (Sanders and Nagata, 2003), and (3) it is more scientific and reliable than most other traditional methods (Lee, 2007).

Even though this approach is considered widely accepted compared to the other approaches, the biggest weakness of this method is the difficulty of finding an un-impacted continuous period (Lee, 2007; Ibbs and Liu, 2005). Moreover, the credibility of the expert witness plays a crucial role in the success or failure of the submitted cumulative impact claim. For instance, in J.A. Jones Construction Co, the Board of Contract Appeal rejected the contractor's attempt to recover losses while adopting an expert's own variation of a measured mile approach after considering the expert's methodology to be flawed (J.A. Jones Constr. Co., ENG BCA 153,099-105) since the latter had failed to isolate specific impacts caused by individual changes or eliminate other potential causes of loss of productivity on the unchanged work. This case highlights the importance of selecting particular method to prove quantum and resultant injury, and of cautiously selecting an expert who has the required knowledge to calculate loss of productivity in construction projects.

The defendant can challenge the claimant's use of the measured mile approach by claiming that the latter's productivity baseline is not accurate and faulty.

2.4.1.1.5 Baseline Productivity Analysis

To overcome the shortcomings of the measured mile approach, many researchers have developed new methodologies and techniques to develop a productivity baseline.

1. 2.4.1.1.5.1 Baseline Method by Thomas:

Similar to the measured mile analysis, the baseline method also relies on the actual performance of the contractor; however, contrary to the measured mile approach, there is no need to define un-impacted and impacted periods for base line productivity. The base line period is thus the period in which the contractor had its best productivity (Thomas and Zavrski, 1999). In addition, and unlike the measured mile analysis, the baseline productivity is based on individual productivity values as means of reflecting the contractor's performance better than using one single cumulative productivity value for a certain period. The below table delineates the difference between the measured mile method and the baseline method.

Table 5: Difference between the measured mile and base line period (Thomas and Sanvido, 2000)

Measured Mile	Baseline Period
The negative impacts should be limited to those caused solely by the contractor.	The baseline period need not be free of owner impacts.
The measured mile time frame should be several or more consecutive reporting periods.	The baseline time frame need not be consecutive reporting periods.
The focus is on finding periods of time where there are no owner-caused impacts.	The focus is on finding the best performance the contractor could achieve.

Accordingly, Thomas and Sanvido (2000) and Thomas and Zavrski (1999) proposed the below five steps for calculating the baseline productivity:

- Determine 10% of total workdays.
- The determined number shall be consequently rounded to the next highest odd number; this number should not be less than 5 and it defines the size of the baseline subset.
- The contents of the baseline subset are selected as the "n" number of days that have the highest daily production or output.
- For these days, daily productivity shall be analyzed.
- The baseline productivity is the median of the daily productivity values of the baseline subset.

The advantages of this method is that it overcomes some key shortcomings of the measured mile approach considering that it does not require the use of continuous un-impacted period and in the same time it reflects variations in the productivity data through using individual productivity values.

As for the disadvantages of the subject method, Ibbs and Liu (2005) identified the major limitations of this approach as summarized here below:

- This method identifies the baseline sample based on the best daily output and not the best daily productivity. One case is that the output level can vary depending on crew size; the higher the crew size, the higher the produced output. Accordingly, a data point with lower productivity but higher output might be chosen over another point with higher productivity but lower output which in terms contradicts the basic definition of the baseline.
- The 10% requirement is not based on any scientific requirement. Moreover, the 10% sample is a presumption of 10% of the time that similar work is being performed and not 10% of the total project.
- (Thomas et al., 2002) used in one study the average and not the median which renders Thomas inconsistent in performing the fifth step of the procedure.

2. 2.4.1.1.5.2 Statistical Process Control Method by Gulezian and Samelian (2003):

The method proposed by the Gulezian and Samelian requires the baseline productivity to be based on values that correspond to a state of statistical control which represents normal operating conditions and/or average level of performance. This can be achieved by considering variability in productivity. Use of a process control chart is proposed for this purpose (Gulezian and Samelian, 2003).

The advantages of this method – when compared to the measured mile approach – is that it also does not require a continuous un-impacted period and takes into consideration the variations to the productivity data by using individual productivity values (Lee, 2005). In the said method, the baseline chart can also be applied to individual productivity values in dispute to determine if any is unusual and consequently which individually is attributed to the employer/employer.

Theoretically speaking, this method assumes that the baseline productivity is the normal productivity. Through the process, both the worst and the best productivities are eliminated. This can be regarded as a major disadvantage to contractors. The calculated baseline productivity includes quite a lot of inefficiency. Moreover, questions arise regarding the use of 3 standard deviations as the control limits to the construction operations. (Lee, 2003).

3. 2.4.1.1.5.3 Statistical Clustering Method by Ibbs and Liu (2005):

Ibbs and Liu proposed the use of statistical clustering technique to find the un-impacted productivity as the baseline for comparison. The main purpose of the clustering method is to separate the data into different groups based on the similarity of the data points. The subject method categorizes the productivity data points into two main categories: “impacted and un-impacted”.

The researchers claim that this method is more objective than that of Thomas’s due to the fact that the selection of the reference period is based on an impartial and statistical clustering procedure. The sample size is thus selected by the characteristic of the data themselves rather than an arbitrary rate similar to Thomas’s 10%.

The researchers categorized all data-points only into two groups "impacted and un-impacted" disregarding any other criteria/categorization.

2.4.1.1.6 Comparison Table Developed by Lee (2005)

Lee (2005) developed a comparison table highlighting the differences between the three improved methods and the measured mile method. This table is considered as an expansion to comparison table by Ibbs and Liu (2005).

Table 6: Comparison of Feautures of Improved Methods and Measured Mile Mehtod (Lee, 2005).

	Measured Mile	**Thomas and Others**	**Gulezian and Samelian**	**Ibbs and Liu**
Purpose	Find periods where there are no owner-caused impacts	Find contractor's best performance based on output level	Find contractor's normal performance corresponding to a state of statistical control	Find contractor's best performance
Who's responsible?	Contractor	Owner/contractor	Owner/contractor (assignable causes)	Owner /contractor
Consecutive time periods?	Yes	Not necessary	Not necessary	Not necessary
Record of delay causes needed?	Very detailed	Somewhat detailed	Somewhat detailed	Somewhat detailed
Sample size	Reasonable	10% of project duration	Depends on project characteristics	Depends on project characteristics
Relative conservative-ness of productivity loss calculation**	Varies case by case	Least conservative calculation (focus on best productivity)	Most conservative calculation (baseline reflects a quite amount of inefficiencies)	In between Thomas's and Gulezian's calculation

**Relative conservativeness refers to how conservative the productivity loss is calculated. That is, the smaller productivity loss, the more conservative the method.

2.4.1.2 Developed Statistical Models and Studies:

Provided that there is a sufficient amount of data, statistical regression models are one of the most scientific methods to quantify the cumulative impact of changes. For the aim of this research statistical studies and available regression models were identified in the literature and listed in order of presentation vide Table 9 below:

Table 7: Statistical Studies and Methods from the Literature

Statistical Studies and Methods	**Reference(s)**
Heather (1967)	Heather, P.R., "Mathews Curve - A Model for Evaluating Impact," AACE Transactions, I-4, 1989. pp. I.4.1-I.4.6.
Leonard (1988)	● Leonard, C.A., The Effects of Change Orders on Productivity. MS Thesis, Concordia University, Montreal, 1988. ● Leonard, Fazio, and Moselhi, "Construction Productivity: Major Causes of Impact," AACE Transactions, D-10, 1988 ● Moselhi, 0., Leonard, C., and Fazio, P., "Impact of Change Orders on Construction Productivity," Canadian Journal of Civil Engineering, Vol. 18, 1991. pp 484-492.
Thomas and Oloufa (1995)	Thomas, H.R. and Oloufa, A.A., "Labor Productivity, Disruptions, and the Ripple Effect," Cost Engineering, Vol.3 7, No.12, 1995.
Thomas and Napolitan (1995)	Thomas, H.R. and Napolitan, C.L., "Quantitative Effects of Construction Changes on Labor Productivity," Journal of Construction Engineering and Management, Vol.121, No.3, September, 1995.
Ibbs and Allen (1995;1997)	● Ibbs and Allen, Quantitative Impacts of Project Change. Report to CII, Technical Report No.23, Department of Civil Engineering, CEM, UC Berkeley, 1995 ● lbbs, "Quantitative Impacts of Project Change: Size Issues", Journal of Construction and Engineering Management, Vol.123, No.3, 1997
Ibbs (2005)	● Ibbs, "Impact of Change's Timing on Labor Productivity," Journal of Construction and Engineering Management, Vol.131, No.11, 2005.

Impact and Quantification Methods by Hanna	● Lee, M.J., Hanna, A., and Loh, W.Y., "Decision Tree Approach to Classify and Quantify Cumulative Impact of Change Orders on Productivity," Journal of Computing in Civil Engineering, 18(2), April, 2004. pp. 132-144. ● Hanna, A.S. and Russell, J., "Closure to "Impact of Change Orders on Labor Efficiency for Electrical Construction" by Hanna, Russell, Nordheim, and Bruggink," Journal of Construction Engineering and Management, 128(4), July/ August 2002. pp. 363-364. ● Hanna, A.S., "Closure to "Quantitative Definition of Projects Impacted by Change Orders" by Hanna, Camlic, Peterson, and Nordheim," Journal of Construction Engineering and Management, ASCE. 130(4), July/August 2004. pp. 612-613. ● Hanna, A.S., Quantifying the Cumulative Impact of Change Orders for Electrical and Mechanical Contractors. Research Summary 158-1, CI!, October, 2000. ● Hanna, A.S., Quantifying the Cumulative Impact of Change Orders for Electrical and Mechanical Contractors. CII Research Report 158-11. February, 2001. ● Hanna, A.S. and Sullivan, K.T., "Impact of Overtime on Construction Labor Productivity," Cost Engineering, AACE International, 46(4), April, 2004. ● Hanna, A.S., Chang, C.K., Sullivan, K.T. and Lackney, J.A., "Shift Work Impact on Construction Labor Productivity," ASCE Construction Research Congress 2005. April 5-7, 2005b. ● Hanna, A.S., Taylor, C.S., and Sullivan, K.T., "Impact of Extended Overtime on Construction Labor Productivity," Journal of Construction Engineering and Management, 131(6), June, 2005c. pp. 734-739. ● Hanna, A.S., Chang, C.K., Lackney, J.A., and Sullivan, K.T., "Overmanning Impact on Construction Labor Productivity," ASCE Construction Research Congress 2005. April 5-7, 2005a. ● Hanna, A.S., Camlic, R., Peterson, P.A., and Nordheim, E.V., "Quantitative Definition of Projects Impacted by Change Orders", Journal of Construction and Engineering Management, Vol. 128, No.I, February, 2002. ● Hanna, A.S., Peterson, P.A., and Lee, M.J., "Benchmarking Productivity Indicators for Electrical/Mechanical Projects," Journal of Construction Engineering and Management, Vol. 128, No. 4, July/August 2002, pp. 331-337. ● Hanna, AS., Russell, J., and Thomack, D., "Quantifying the Effect of Change Orders on Electrical Construction Labor Efficiency", Cost Engineering, Vol. 40, No.2, February, 1998. ● Hanna, AS., Russell, J., Nordheim, E.V., and Bruggink, M., "Impact of Change Orders on Labor Efficiency for Electrical Construction," Journal of Construction Engineering and

	Management, 125(4), July/August, 1999c. pp. 224-232. ● Hanna, A.S., Russell, J., and Bruggink, M., Impact of Change Orders on Labor Efficiency for Electrical Construction. A Summary of the Technical Report to the Electrical Contracting Foundation, 1999d. ● Hanna, A.S., Russell, J., and Vandenberg, P.J. "The Impact of Change Orders on Mechanical Construction Labour Efficiency," Construction Management and Economics, Vol. 17, No. 6, 1999a. pp. 721-730. ● Hanna, A.S., Russell, J., Gotzion, T.W., and Nordheim, E.V., "Impact of Change Orders on Labor Efficiency for Mechanical Construction", Journal of
Artificial Intelligence Approach: Neural Networks Model	Lee, M.J., Artificial Intelligence Approach to Classify and Quantify Cumulative Impact of Change Orders on Labor Productivity. Ph.D. Dissertation, The University of Wisconsin-Madison, WI. 2002.
Artificial Intelligence Approach: Decision Tree Model	Lee, M.J., Hanna, A., and Loh, W.Y., "Decision Tree Approach to Classify and Quantify Cumulative Impact of Change Orders on Productivity," Journal of Computing in Civil Engineering, 18(2), April, 2004. pp. 132-144.

2.4.1.3 How to Maximize Utilization of Currently Available Productivity Loss Data and Quantification Methods

Most of the quantification techniques that have been used have not been a subject of extensive critique and analysis in a consistent and scholarly manner. Moreover, all previous reviews have lacked the development of a properly organized framework that can link and organize studies.

Lee (2007) conducted a thorough research attempting to bridge the gap between existing methodologies (including academic models and studies) and their practical and proper application. Lee aimed to identify methods which are more reliable or appropriate in specific situations, compare studies and models in terms of reliability and applicability, and develop guidelines that can help practitioners decide on the best approach and/or quantitative method to be used.

In the case of construction projects suffering from a substantial number of change orders, the use of the above mentioned methods might be leveraged to quantify the cumulative impact (synergistic effect) of these change orders. Lee (2007), suggested a general decision process of choosing the quantification method to be utilized.

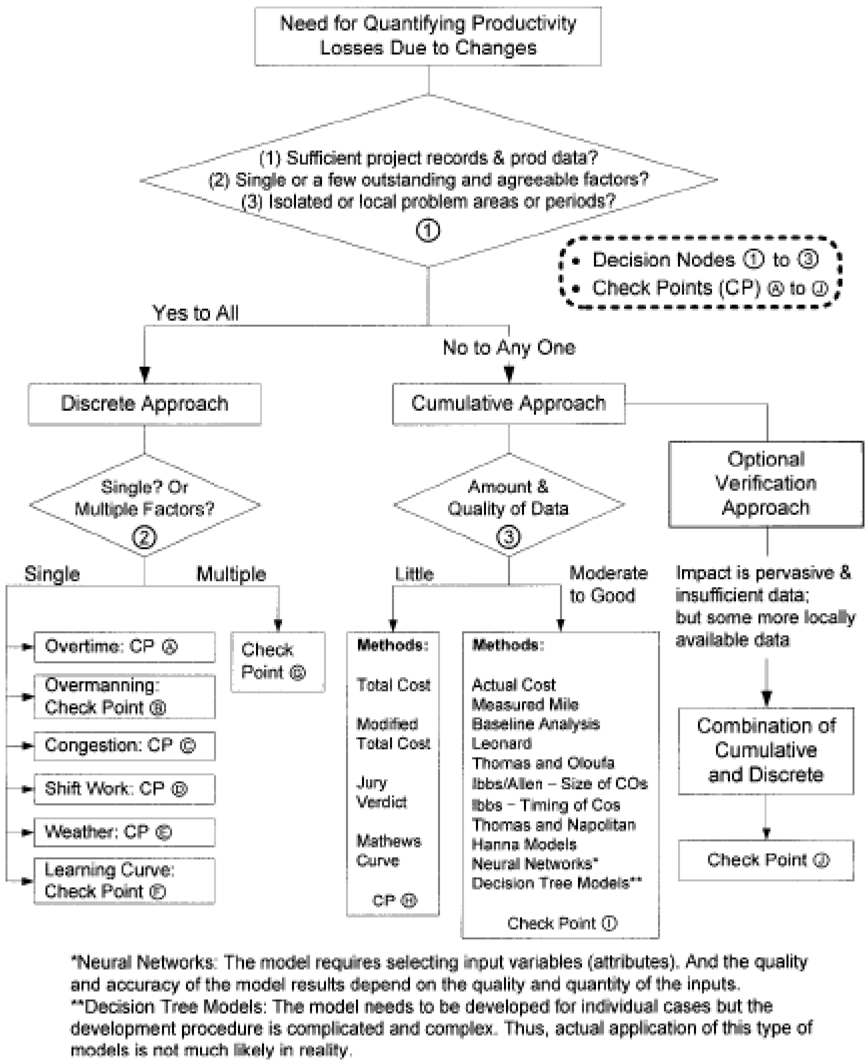

Figure 5: Decision Process for Choosing Quantification Methods (Lee, 2007)

As illustrated, the decision tree proposed by Lee has three decision nodes and ten final option nodes (labeled A to J). At each of the final option nodes, users can choose a specific or multiple quantification method by considering issues and points relevant to the particular method(s) under that option. A full elaboration on the proposed decision process can be accessed vide Lee's research titled "Understanding and Quantifying the Impact of Changes on Construction Labor Productivity: Integration of Productivity Factors and Quantification Methods".

CHAPTER 3

QUANTIFYING VOLUME AND IMPACT OF CHANGES

3.1 Introduction:

As previously mentioned above, the large volume of contract variations can be viewed and expressed differently by the employer and the contractor. This gives rise to different perspectives in relation to the treatment of the large volume of changes and thus to different approaches in packaging contract variations' related claims. In projects experiencing a substantial amount of change orders, and after having already agreed to the individual impact of each change order/variation, contractors attempt to recover unrecovered/unforeseeable cost and time implications vide different approaches which in term are related to its own perspective in treating the large volume of experienced contract changes. In light of the aforesaid, this chapter examines the records of two cases that represent different employer's and contractor's perspectives in regard to treating the large volume of contract variations along with the different contractors' and employer's strategies with regards to quantifying the volume and the impact of change orders. The latter is preceded with a brief analysis of FIDIC 1987, 1999, and 2017 standard form of contract's clauses related to valuation of variations particularly those related to the volume, nature, and cumulative impact of changes.

3.2 FIDIC Standard Form of Contract:

3.2.1 FIDIC 4th Edition (1987) Red Book

Under the FIDIC 1987 standard form of contract, the authority to make any adjustment to the works is clearly stated under sub-clause 51.1 whereby "The Engineer shall make any variation of the form, quality or quantity of the Works or any part thereof that may, in his opinion, be necessary and for that purpose, or if for any other reason it shall, in his opinion, be appropriate, he shall have the authority to instruct the contractor to do and the contractor shall do" (FIDIC 1987). Accordingly, the engineer is vested the power to put forward changes and variations as long as it does not vitiate or invalidate the contract (El-adawy et. al, 2016).

Furthermore, FIDIC 1987 explicitly covers the issue of variations exceeding 15% either in additions or deductions. Sub-clause 52.3 of the same stipulates the following: "[where] there have been additions to or deductions from the Contract Price which taken together are in excess of 15% of the Effective Contract Price . . . then and in such event (subject to any action already taken under any other Sub-Clause of this Clause), after due consultation by the Engineer with the Employer and the Contractor, there shall be added to or deducted from the Contract Price such further sum as may be agreed between the Contractor and the Engineer or, failing agreement, determined by the Engineer having regard to the Contractor's Site and general overhead costs of the Contract."

3.2.1.1 Sub-clause 51.1: Variations

This clause empowers the engineer to order omissions, additions, and/or variations to the works that are to be valued under clause 52. Such variations are in the opinion of the engineer "be necessary… be appropriate". If the contractor challenges the engineer's instruction and considers that the work is not appropriate or necessary, it can resort to clause 67 (Disputes). The last paragraph in this clause stipulates that "no such variation shall in any way vitiate or invalidate the contract". The word "such" refers back to points (a) to (f) of this clause and thus it can be interpreted that variations shall not alter the fundamental basis of the contract; the engineer has the right to "vary under the contractor and not the contract itself" (Corbett, 1991).

3.2.1.2 Sub-clause 52.2: Power of Engineer to Fix Rates

The subject sub-clause clearly stipulates that "Provided that if the nature or amount of any varied work relative to the nature or amount of the whole of the Works or to any part thereof, is such that, in the opinion of the Engineer, the rate or price contained in the Contract for any item of the Works is, by reason of such varied work, rendered inappropriate or inapplicable, then, after due consultation by the Engineer with the Employer and the Contractor, a suitable rate or price shall be agreed upon between the Engineer and the Contractor."

It is not clear whether the conditions under which the varied works are executed are relevant to this clause and allow an alteration of rates knowing that the statement "the nature . . . of any varied works" leaves the issue debatable. However, it is submitted that all the circumstances of a variation/change order along with other works, directly or indirectly affected, are relevant for consideration under sub-clause 52.3 (Corbett, 1991). Such a clause, does not only target the rate applicable to the varied works, but any "rate or price contained in the Contract for any item of the Works …" which is by reason of such varied works rendered inapplicable or inappropriate. Thus, for instance, if the quantity of a certain item of work has increased 60%, this clause poses the question whether the rate for that item shall be adjusted and not only the rate related to the additional work.

Moreover, the works might be varied by an omission of a certain part thereof. In this case, and in a lump sum contract, the contractor may wish to claim for overhead and profit elements of the omitted works; it is submitted that this yields in a fair result (Corbett, 1991). Another possible difficulty that might be incurred by the contractor is in the case where the contractor had no intention to claim extra payment and failed to submit a notice within 14 days as required under this sub-clause; however, the latter discovered at a later stage that the varied works are such as to render the rates inappropriate. In such cases it may be very debatable whether a notice is required or not and the matter shall be referred to an arbitrator/legal council to conclude. Another important question arises in the case when rates or prices have been agreed upon between the engineer and the contractor; is such an agreement open to a challenge between the employer and the contractor?

This highlights a vital issue which is related to foreseeability and waiver and whether the contractor can recover cumulative impacts/unforeseeable impacts at a later stage without being considered to have waived its right to do so. The contractor may also argue that the additional work has caused disruptions and additional costs rendering the rates inapplicable and triggering sub-clause 52.2.

3.2.1.3 Sub-clause 52.3: Variations Exceeding 15 per cent

It is not entirely clear whether the figure to be compared with the contract price is the “net impact” or the “absolute” impact of variations taken together as a whole. According to Corbett practical legal guide, in the first instance, it might be clear that the net impact shall be considered; however, it is to be submitted that the two figures shall be added.

Regarding the adjustments that can be made to the contract price, it is stipulated that a sum to be "determined . . . having regard to the Contractor's site and general overhead costs" but " such sum shall be based only on the amount by which the additions or deductions shall be in excess of 15% of the Effective Contract Price".

Whilst it is sometimes considered that this sub-clause is for the benefit of the contractor, it can be the case that the increase in the volume of the works has resulted in an over-recovery of overheads which can be nullified by the employer/engineer.

It can be evident that the major aim of sub-clause 52.3 refers to the situation when the total effect (volume) of all variations results in an increase or decrease of more than 15% knowing that it is possible that each variation – if taken alone – might not have had a significant impact on the contractor's overhead; however, these variations, if looked at collectively, might have a substantial impact on the latter.

3.2.1.4 Key Takeaways:

The above is a clear acknowledgement that volume of changes matters and that the cumulative impact of changes is an inherent concept in the FIDIC 1987 standard form of contract. The difference between sub-clause 52.2 [Power of Engineer to Fix Rates] and 52.3 [Variations Exceeding 15 per cent] is that there may be an accumulation of variations and changes in quantities and/or quality, none of which - when taken alone – qualify for re-rating under sub-clause 52.2 (Corbett, 1991). Thus sub-clause 52.3 addresses the issue of the cumulative impact of changes (synergistic effect), clause 52.2 clearly addresses the issue of the volume of changes, and clause 51 can underline that the instructed variations shall not vitiate the contract (it should be necessary and appropriate). Notwithstanding, it shall be noted, that in clause 52.3 it is not explicitly stated whether the “net impact” or the “absolute impact” shall be taken into account which might be a subject of different interpretations and perspectives by the contracting parties.

3.2.2 FIDIC 1999 Red Book

3.2.2.1 Clause 12: Measurement and Evaluation:

FIDIC 1999 is a re-measured contract which makes the risk of any variation to quantities borne by the employer and, in certain cases, the rates and prices which may be applied to the executed works (Corbett & Co International Construction Lawyers, 2016). Sub-clause 12.1 deals with the measurement of the works and describes the procedure for measuring the quantity of each item of work. This clause has its origins in clauses 52, 56, and 57.1 of the FIDIC 4^{th} editions (1987). If the employer prefers to have a lump-sum contract then this clause must be deleted (Corbett & Co International Construction Lawyers, 2016; FIDIC Contracts Guide 2000).

Sub-clause 12.2 deals with the method of measurement without including any reference to a standard method of measurement; it only stipulates that the method of measurement shall be in accordance with the bill of quantities or other applicable schedules except as otherwise stated or specified under the contract (FIDIC 1999). The lack of reference to a particular standard method of measurement has been criticized (Jaeger and Hok, 2010).

Sub-clause 12.3 deals with evaluating appropriate rates and prices for the works. In certain defined circumstances, a new rate or price shall be specified and applied. Under normal circumstances, the rate or price specified for such item in the contract, or such rate for similar works, shall be applied (FIDIC Contracts Guide 2000). These circumstances are delineated under sub-paragraphs (a) and (b) of the subject sub-clause. According to sub-paragraph (a) it is possible for the contractor to claim for a new rate under sub-clause 12.3 on the basis of additional quantities if the below criteria have been satisfied:

1. “The measured quantity of the item of work must be less than 90%, or more than 110%, of the quantity stated in the Bill of Quantities. This criterion is consistent with the principle that Bill of Quantities provides only an estimate – see Sub-Clause 14.1(c)”.
2. “When the difference in quantity (namely, the difference between the Measured Quantity and quantity in the Bill of Quantities) is multiplied by the rate per unit quantity stated in the Bill of Quantities, the result must be more than 0.01% of the Accepted Contract Amount. This criterion is specified in order to avoid adjusting a rate if the adjustment will have little effect on the final Contract Price”.
3. “The difference in quantity (namely, the difference between the Measured Quantity and quantity in the Bill of Quantities) must have affected the "Cost per unit quantity", which is the cost incurred by executing the work covered by the item, divided by the quantity of the item as measurable in accordance with the applicable method of measurement”.
4. “The Contract must not have used phrase "fixed rate item" in relation to the item in the Bill”.

(FIDIC Contract Guide 2000; (Corbett & Co International Construction Lawyers, 2016).

The first two criteria are related to changes in quantities, the third criterion is related to effects on costs, and the fourth criterion allows the preclusion of adjustments of some items. If the four criteria above were satisfied, the "Bill rate would typically be changed in proportion to such change in cost per unit quantity which was the direct result of the change in quantity. In other words, the rate per unit quantity would be adjusted pro rata to the proportion (Cqm/QM) / (Cqb/QB)" (FIDIC Contracts Guide 2000).

Furthermore, sub-paragraph (b) specifies the criteria relating to works instructed under Clause 13 [Variations and Adjustments]. In this case a new price or rate will be considered appropriate if "no rate or price is specified in the Contract for this item, and no specified rate or price is appropriate because the item of work is not similar in character, or is not executed under similar conditions, as any item in the Contract" (FIDIC 1999). Accordingly, and in other words, when the works subject to a variation/change order cannot be evaluated under the normal circumstances mentioned here above, then sub-paragraph (b) of sub-clause 12.3 applies.

In Galliford (UK) Ltd v. Aldi Stores Ltd, it is illustrated that such provisions can have significant effects on the contractor's costs. In the latter, the judge Bowsher QC had to consider a claim for additional payment for the contractor that had specified a rate of £0.00 in its bill of quantities allocated for the removal of contaminated material. On the other hand, the employer considered that the contractor is not entitled to recover any monies related thereto. The court, in its turn, held that the contractor is not entitled for any recovery/compensation since the latter had not proven that there had been a significant change to the quantity of the works and/or the works were not carried out under similar working conditions.

Similarly, Henry Boot Construction v. Alston Combined Cycles, Lord Lloyd held that:

“If the Engineer were free to open up the rates at the request of one party or the other because they were inserted in the Bill of Quantities by mistake, it would not only unsettle the basis of competitive tendering, but also create the sort of uncertainty in the administration of building contracts which should be avoided at all costs.”

However, when the mistake does not reflect the common intention of the parties then the courts may be able to interpret the contract wording to eliminate ambiguities.

3.2.2.2 Clause 13: Variations and Adjustments:

This clause deals with the engineer’s right to vary the contract. Sub-clause 13.1 includes a list of items which may constitute a variation under the contract but it does not attempt a wholly inclusive definition. Moreover, none of the items in sub-clause 13.1 contemplate any substantial departure from the original scope of the works. It is therefore arguable that, in the absence of any other clarification and stipulation highlighting what is intended by the word “variation” in the contract, then the concept of variation is not intended to allow the employer to instruct a cardinal change to the works and/or expand the scope of works in any significant way whereby according to Corbett & Co International Construction Lawyers (2016):

“Paragraph (a) allows changes of quantities, but does not contemplate new items. Paragraph (b) contemplates changes to quality and characteristics of items but, again not new items. Paragraph (c) simply deals with topographical changes to the originally contemplated works. Paragraph (d) is only about omission of work. Although Paragraph (e) refers to additional work this additional work is limited to that necessary for the originally contemplated Work and Paragraph (f) again only refers to a change to the sequence or timing of what was originally intended".

In light of the above, despite the fact that contractors normally welcome the opportunity to collect additional compensation for additional works, in some situations the latter might be incapable to commit to such additional works knowing that it may be outside of its normal capability and/or outside its scope of work (refer to Chapter 5 of this research related to cardinal changes).

3.2.2.3 Key Takeaways:

In light of the above, it can be deduced that FIDIC 1999 standard form of contract does not explicitly mention the "volume of changes". It seems that sub-clause 52.2 (Variations Exceeding 15 per cent) of FIDIC 1987 got diffused in FIDIC 1999 whereby clause 12.3 enumerates a number of a criteria that shall be met to allow the use of a new rate. Thus the issue of the "volume of additional work" was implicitly targeted knowing that the contractor can claim a new rate under sub-clause 12.3 on the basis of additional quantities. If the four criteria are met, the bill rate would typically be changed in proportion to such change in cost per unit quantity which is the direct result of the change in quantity. In such a rate the contractor can try to recover the cumulative effect of all changes.

Notwithstanding, it shall also be noted that clause 13 of the conditions of contract is not intended to allow the employer to order a cardinal change to the works. It can be argued that in the absence of any other clarification of what is intended by the term "Variation" - other than what is mentioned in sub-clause 13.1 - the concept of the variation is not intended to allow the employer to expand the scope of works in a substantial and significant manner. None of the items listed under sub-clause 13.1 contemplate any cardinal departure from the original scope of the contract.

3.2.3 FIDIC 2017 Red Book

<u>3.2.3.1 Clause 12: Measurement and Evaluation:</u>

There has been no major changes between the 2017 version and the 1999 version with regards to clause 12 and the measurement and valuation of variations.

<u>3.2.3.2 Clause 13: Variations and Adjustments:</u>

Whilst the process of ordering variations has not been dramatically altered, the 2017 FIDIC edition classified some limits on the engineer's right to vary. As stated here above, under FIDIC 1999 it the engineer's right to vary was not explicitly limited to the scope of the contract which opens up questions similar to what constitutes a cardinal change to the contract. Most legal systems, as discussed here above and elaborated in Chapter 5 (Cardinal Changes), do not contemplate a variations that depart significantly from the original scope of the contract. In FIDIC 2017, the contractor is given the right to object on any variation if "the varied work was Unforeseeable having regard to the scope and nature of the Works described in the Specifications" (FIDIC 2017). The term "Unforeseeable" was defined under 1.1.85 as "not reasonably foreseeable by an experienced contractor by the Base Date". Unlike FIDIC 1987 and 1999, it can be implied that FIDIC 2017 somehow targets the concept of cardinal changes to the works and the contractor can upon "promptly" giving a notice to the engineer object on a certain variation that is considered outside the latter's scope of work and the engineer must also respond "promptly". However, the engineer has the option to cancel, confirm, or vary the instruction. If the latter chose to cancel, and the contractor held on its objection, a dispute might arise between the parties as to whether or not the contractor's objection is valid.

Regarding the procedure for variations, the 2017 editions follows the same model as the 1999 editions whereby it is provided that a variation order could be either commenced by a direct instruction or by a request for proposal. However, the difference between FIDIC 2017 and the previous editions, is that the contractor can seek compensation – pursuant to Sub-clause 13.3.1 (c) - for "any loss of profit and other losses and damages suffered" in case omitted works is to be carried out by others. It would seem that the contractor can opt to include consequential damages and include losses and damages in its proposal. This opens the door to very substantial and/or complex claims that might be put forward by contractors. Moreover, it is one way for the contractor to seek loss by an unforeseeable variation and/or any abuse of the variations clause by the employer/engineer.

3.2.3.3 Key Takeaways:

It is evident that the FIDIC 2017, and unlike the previous versions, addresses in a direct manner the issue of cardinal changes to the works and links it to the concept of foreseeability. However, defining or considering if an issue was foreseeable by an experienced contractor, is a subject of dispute between the parties especially if the employer/engineer grasp the position of considering that the variation is within the scope of work.

Nonetheless, the contractor is allowed under the FIDIC 2017 standard to recover loss of profit or damages in case the omitted works are to be carried out by others. Such stipulation was absent in the previous standard forms whereby neither party was liable for the other party's loss of profit.

3.3 Employer Strategies: Common Defenses Employed by the Employer

3.3.1 Signed Change Orders Constitute Accord and Satisfaction

The most common defense mechanism employed by the employer/engineer is including waiver language while signing a change order. The employer/engineer contend that the contractor, by signing a change order, has agreed to all direct and indirect impacts that result therefrom. This defense mechanism, as stated here above is, in legal terms, referred to as "accord and satisfaction". The burden of proof of accord and satisfaction is upon the employer/engineer. (Atlantic Dry Dock Corp. v. United States, 773 F. Supp. 335 (1991); Jackson Construction Co. Inc. v. United States (2004); Magnolia Constr.. v. Parish of St. Charles, 06-543(La.App. 5 Cir. November, 28, 2006)).

On the opposing side, in order to defeat the employer's/engineer's defense, the contractor must prove that there was no meeting of the minds while negotiating the impacts of a particular change order and that the contractor did not intend when pricing a particular change order to price the impacts derived from the overall synergistic effect of these change orders that resulted in a cumulative impact. It is also always beneficial for the contractor to reserve its rights for cumulative impact and point out to some reservation language in official means of communication. The contractor can reserve its right to collect any future cumulative impacts directly or indirectly related to the change order itself under equitable adjustment.

For instance, the in Bell BCI Company Inc. v. United States, the Court of Appeals held that the contractor had not effectively released and waived its rights to collect cumulative impact and the doctrine of accord and satisfaction was not enforced. The court considered that there was no meeting of the minds as to a release of cumulative impact claims.

In Jackson Construction Co. Inc. v. United States (2004), the court demonstrated the difference between an accord and satisfaction defense and a release defense on cumulative impact claims. It noted that a "release constitutes no condition precedent to discharge by accord and satisfaction." It further recorded that the court under accord and satisfaction had to concentrate on the intention of the parties and whether there was a meeting of their minds. It explained that with a release, the court could "void or reform the release on several grounds, including lack of consideration, lack of performance, lack of authority, unilateral or mutual mistake, misrepresentation, duress, or under other circumstances in which the parties' conduct evinces an intent to allow additional claims."

3.3.2 Contractor Lack of Causation and Failure to Apportion the Losses and Disruptions

The employer can defeat the contractor’s claim by proving that a portion of the cost overrun was as result of the contractor’s own inefficiency (Huber, Hunt & Nichols v. Moore, 67 Cal.App.3rd 278 (1977); Pittman Construction Co. v. United States (GSBCA Nos.4897, 4923, 81-1 BCA, 1983)). As discussed here above, some courts do not require to pinpoint every encountered damage/delay and link it to a specific event/change order; however, the contractor shall be able to prove and show that the synergistic effect and the substantial number of change orders have affected the productivity on site and impacted unchanged works also. As mentioned here above, the contractor can prove that the substantial number of changes has resulted in a change in the working conditions knowing that the focus of causation disputes is “working conditions” (Fitzgerald, 2002; Backus 2003). The contractor can prove that “the disrupting changes and disrupted work took place in the same area or used the same resources, or that performance of the changes was a prerequisite to performance of the unchanged work” (Finke, 1997).

3.3.3 Impact of Changes was Foreseeable and Could Have Been Tracked

As mentioned here above, the employer can try to defeat the contractor’s cumulative impact claim by attesting that the latter has failed to keep contemporary records and track the impact of each change order. The employer can underline that the contractor should have been able to track changes and accurately estimate all impact changes while negotiating change orders. Many contractors, due to poor project management practices and maintenance of records, fail to foresee the impact of changes until incurring indirect costs at the near end of the project’s completion (Ibbs and Allen, 1995). With the development of data management systems and quantitative analysis, courts now expect contractors to utilize technological assessments to establish causal nexus. According to Backus (2010), the cumulative impact claim should require the following proof:

- Impact attributable to changes was excluded from change order settlements or was unenforceable.
- The substantial amount of changes was the sole cause of disruption.

- The cumulative impact was unreasonable and excessive in relation to what the contractor might have expected at the time of negotiating the impact of change orders.
- Impact costs cannot be segregated and isolated.
- Cumulative impact costs can be reasonably proven.

3.3.4 Determining a Clear Procedure to Negotiate Changes and Determine Their Impacts

The employer shall from the beginning of the project determine a clear and lucid procedure to determine the impacts of changes in the project. This procedure can be explicitly stated in the contract documents delineating the specific requirements that shall be adhered to for proving causation and liability. Moreover, the contracting parties can try to form an ad hoc board of experts or choose one specific neutral expert in order to issue a final determination after utilizing a specific industry practice to determine the resultant injury of the cumulative impact (Hanna and Swanson, 2007).

3.4 Contractor's Strategies: Improving the Contractor's Position

3.4.1 Proving Causation and Resultant Injury

The principal and most obvious proof of cumulative impacts is the fact that the contractor has incurred a substantial amount of changes (and the dollar value of their impact) that were indeed excessive and cannot be contemplated for, while entering into the contract. Accordingly, the prime consideration is the frequency of changes along with giving attention to the timing of these changes throughout the project timeline. The more consecutively the changes were introduced, the more complex is the contractor’s ability to thoroughly anticipate the indirect impact of these changes was (Backus, 2010).

3.4.2 Proving that Cumulative Impact Caused by Excessive and Frequent Changes has Impacted Working Conditions

As mentioned above, in order for the contractor to defeat the employer’s defenses (namely: relying on accord satisfaction by contractual waiver and failure to prove causation), the contractor shall prove, by relying on records and experts, that the substantial number of changes has affected working conditions (Hanna and Swanson, 2007; Backus, 2010).

3.4.3 Accounting for all Foreseeable Work, Risk, and Working Conditions

While preparing its bid, the contractor shall try to construct a risk register that incorporates all contingencies and risks which the contractor might be prone to. The contractor shall consequently try to negotiate these risks and/or otherwise attempt to incorporate same within its bid price. If the contractor’s accounting system cannot segregate change orders’ costs and man-hours costs, the contractor shall always reserve its right to recover indirect costs (if any) at a later stage (Jones, 2001; Popescu et. al, 2007).

3.4.4 Establishing a Productivity Baseline

The contractor shall always attempt to resource load its programme of works and maintain effective and regular tracking of its productivity rates for the various trades and activities. For each activity, the baseline shall establish one reasonable productivity rate per crew which shall subsequently be the basis of productivity fluctuations taking into consideration the "learning process" (Finke, 1997; Backus, 2010).

3.4.5 Records and Documentation

The contractor shall always document and record all changes as soon as they occur. It shall properly document all information available at the time it priced a particular change order to establish afterwards that cumulative impacts where not foreseeable. The contractor shall try to be proactive through projecting the impact of any change on its activities and progress of works. While doing so, the contractor shall bear in mind and keep a close eye on its productivity rates and update it on a regular basis. Any fluctuation or potential impact on the works shall be recorded through official correspondence and the contractor shall regularly submit periodic updates regarding it (Popescu et. al, 2007; Hanna and Swanson, 2007; Bachus, 2010)

The contractor shall always reserve its right to submit a claim for cumulative impact at a later stage while negotiating and signing change orders in order to prevent the employer from using the accord and satisfaction defense mechanism (Lee, 2002; Hanna and Swanson, 2007; Backus, 2010).

3.4.6 Using Experts and Studies

To strengthen its position and increase the admissibility of its cumulative impact claim, contractors shall resort to qualified experts that can assist in proving the existence of its claim. Knowing that many cumulative impacts arise from the contractor's failure to maintain adequate job-site records to allow easy evaluation of cost impacts, experts may attempt to leverage studies on similar projects to estimate the synergistic impact of change orders (Backus, 2010). This will allow the contractor to base its claim on a scientific and pragmatic approach and increase its chances of putting forward a successful claim (Sullivan, 2004; Lee, 2002; Hanna et. al, 2017)). Notwithstanding, experts must be able to provide a level of scrutiny accepted by the courts knowing that courts tend to rely on experts' testimonies to establish the different aspects of the cumulative impact claim (Backus, 2010). Accordingly, in situations whereby the contractor has suffered from productivity loss resulting from the substantial number of changes in the project, the expert should determine the apportionment of these losses between those resulting from compensable changes and those related to non-compensable ones (Finke, 1997).

In addition to the above, the contractor can also resort to having its key personnel, give testimony elaborating on how the synergistic effect of change orders has affected and modified working.

Some of the major methods that have been used and accepted by courts are delineated in Section 2.3 of this research.

3.5 Case Studies:

3.5.1 Case Study 1: Item Fully Impacted v. Item Partially Impacted

3.5.1.1 Case Description

This case represents the contactor's attempt to package its claim through perceiving that a whole integrative item/system has been impacted by a certain change order/contract variation despite the fact that the contract variation(s) had only modified/affected a part/percentage and/or one element of this item. The contractor thereby claims that a substantial percentage of the contract price has been affected by variations; however, as a matter of fact, the employer attempts to prove that only specific parts of these items were affected by a change order/contract variation and thus the impact on the contract price is minimal or considerably lower than that perceived by the contractor. The contractor considered that the introduced changes have ensued a fundamental change to the original design and have accordingly risen to the level of a cardinal change whereby the original scope of works has been qualitatively altered. Accordingly, the contractor considered the time to have become at large whereby the contractor is no longer bound to complete the works within the contractual time and the employer cannot levy liquidated damages if the former failed to do so.

For the purpose of this research, and for data confidentiality concerns, the below is a fictional example to form a clearer picture on the proceedings of the case. Case proceedings:

- The employer and contractor entered into a construction contract to execute and remedy defects the works related to four buildings (blocks A, B, C, & D) along with two underlying basements and landscaping works at ground floor. The general conditions of contract were based on the FIDIC 1987 standard form of contract.
- During the course of construction, the employer/engineer instructed a variation/change order altering the tiling layout and material inside the elevators' car from ceramic to marble. Below is an extract of the bill of quantities related to the elevator works.

ITEM	DESCRIPTION	UNIT	RATE US$	A - COMMON PARTS / CORE AND SHELL												TOTAL	
				1- Substructure &GF external areas		2- Superstructure Block A		3- Superstructure Block B		4- Superstructure Block C		5- Superstructure Block D		TOTAL 1+2+3+4+5+6			
				Quantity	Amount US$	Quantity	Amount US$	Quantity	Amount US$	Quantity	Amount US$	Quantity	Amount US$	QUANTITY	AMOUNT US$	QUANTITY	AMOUNT US$
14.1	SECTION 14210																
	ELEVATORS																
	May be subject to omission/nomination pursuant to Sub-Clause 51.3 of the Conditions of Contract - Package no.C																
	As specified, installed complete with the different and corresponding car finishes, control systems, control panels, motor, sheaves and supporting beams, brakes, counterweights, doors, call registered lights, hall lanterns, cars, electrical installation and switchboards, traction sheaves, control buttons, door hangers and tracks, suspension ropes, guide rails, buffers, controls, safety features, communication systems for electric traction elevators, and including lighting, natural ventilation, intercom, safety gear, governor, car control panel and all materials and accessories which are necessary for the completion and perfect running of the electric traction elevators to the full satisfaction of the Architect-Engineer.																
14.1.1	Passenger Elevators Block "A"	MR	180,964.00			6	1085784							6	1,085,784.00	6	1,085,784.00
14.1.2	Service Elevator Block "A"	MR	170,992.00			1	170992							1	170,992.00	1	170,992.00
14.1.3	Passenger Elevator Block "B"	MR	53,005.47					1	53005					1	53,005.47	1	53,005.47
14.1.4	Passenger Elevators Block "C"	MR	85,236.83							2	170474			2	170,473.66	2	170,473.66
14.1.5	Passenger Elevators Block "D"	MR	80,629.59									2	161259	2	161,259.18	2	161,259.18
14.1.10	Passenger Elevator Gym and Spa	MR	49,888.59	1	49889									1	49,888.59	1	49,888.59
14.1.11	Service Elevator Waste Collection	MR	51,725.26	1	51725									1	51,725.26	1	51,725.26
14.1.12	Preventive maintenance (parts and labor) with a minimum of 1 visit per elevator per months, during the defects liablity period	LS	Included											1			
	Total carried to Collection				101614		1256776		53005		170474		161259		1,743,128.16		1,743,128.16

Figure 6: Sample BOQ related to Case Study 1

3.5.1.2 Contractor's Perspective

The contractor considered that the whole value of USD 1,743,128 has been impacted by the instructed variation. The latter referred to clause 52.3 of the conditions of contract and alleged that the contract price has been impacted by more than 10% (took the whole elevators package value and divided it by the contract price). Notwithstanding, the latter took a rather fallacious perspective, considering that such a variation was an act of prevention by the employer that qualitatively altered the design. The contractor accordingly alleged that the time has become "at large" which prevents the employer from levying liquidated damages and entitles the contractor to complete the works within a time which is reasonable in all the circumstances.

3.5.1.3 Employer's Perspective

The employer, from its perspective, considered the contractor's stance as distorted, ill-founded, and fallacious. The employer underlined that the contractor has wrongfully and fallibly interpreted the contract considering the below:

- The instructed variation only impacted the tiling material and layout inside the elevators' car; the contractor's allegation that the whole value of the elevators package had been impacted is irrational and absurd since the instructed variation only impacts circa 8% of the overall elevator's package only (opposed to 10% of the contract price as claimed by the contractor).
- The contractor's claim that the time has become at large has no contractual basis knowing that it was not a result of any act of prevention by the employer. The employer clarified that the concept of time being

rendered at large is a mere application of the prevention principle in contract law making reference to case law and courts' rulings.

3.5.2 Case Study 2: Absolute v. Net Impact on Contract Price

3.5.2.1 Case Description

This case represents two different perspectives on the treatment of the large volume of change orders/variations. In this case, the employer/engineer has instructed a substantial amount of contract variations that had a vital impact on the cost of completing the works. The employer expresses the volume of the contract variations using the "net impact on contract price" approach to diminish the impact of same whereby the contractor, on the other side, opts to express the volume of contract variations using the "absolute impact on the contract price" as a way to recover its encountered losses.

The below is a sketch that further illustrates the above.

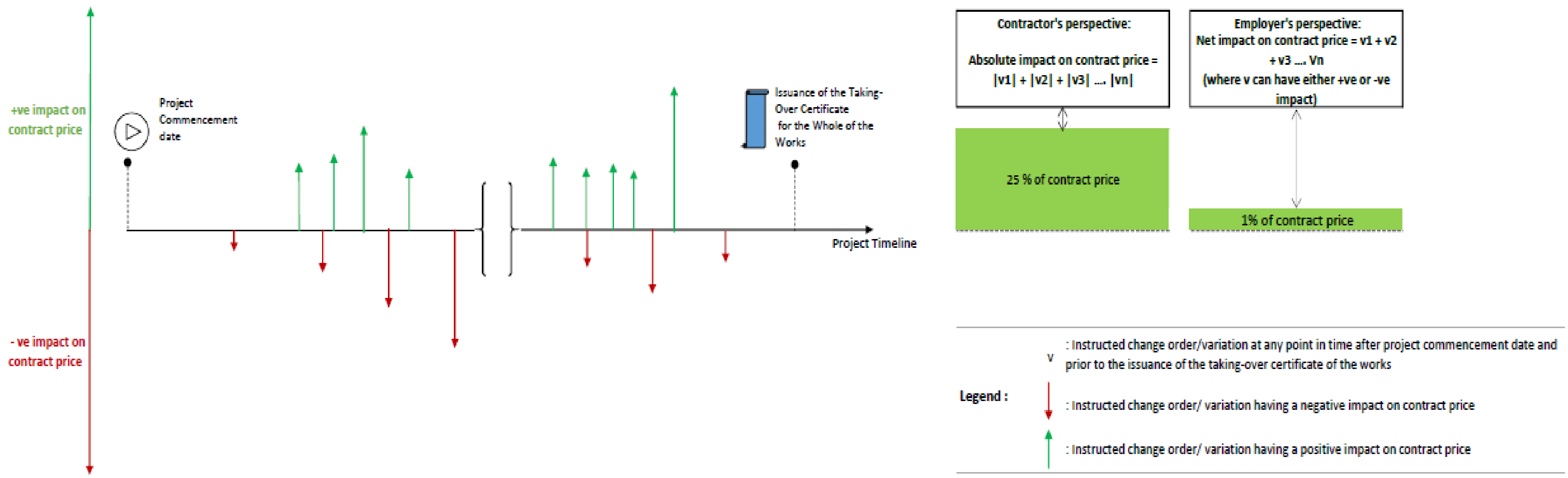

Figure 7: Case Study 2 Elaboration Sketch

The above was also applicable to individual change orders/variations subject to multiple modifications.

3.5.2.2 Contractor's perspective:

The contractor considered that the substantial amount of change orders/variations cannot be merely looked at from a net impact perspective knowing that the same has a cumulative impact on the works. The large number of change orders has created a synergistic disruptive impact and affected the contractor's ability to control productivity and accurately plan the sequence of works. The contractor considered that every change order, despite having a positive or a negative impact on contract price, affects the contractor's performance, productivity, and overhead costs on the project and thus allows the latter to trigger sub-clause 52.3 (under FIDIC 1987) or sub-clause 12 (under FIDIC 1999) and/or a similar clause under the particular conditions of the contract. The contractor consequently declared the time to have become at large after the misadministration of the engineer of the submitted EOT claims coupled with the employer's interference that prevented any EOT to take effect.

3.5.2.3 Employer's perspective:

The employer considered that it is vested the power to order additions, omissions, and/or changes to the works limitlessly as long as the net impact of all variations on the contract price is minimal. The latter abused its power to order variations to the works alleging that the overall impact is nominal and the instructed variations that have a negative impact on the contract price where considered as value engineering proposals.

3.6 Conclusion:

In this chapter it is can be clear that employers and contractors might opt to deploy different strategies and techniques to quantify and express the volume of change orders. Such perspectives can be directly related to each party's interpretation of the contract clauses.

Contract conditions have evolved over time allowing for a rather different interpretation of the latter. Different interpretations result in different approaches towards dealing with the large volume of change orders. Table 10 below summarizes the key takeaways deduced from the comparison made between FIDIC 1987, 1999, and 2017 in relation to how each deals with the volume of change orders.

(Space intentionally left blank)

Table 8: FIDIC standard forms of Contract - Clauses Dealing with Nature of Changes

FIDIC Standard Form	Sub-Clause Reference	Wording of Sub-Clause(s)	Remark
Criteria 1: Nature of Change			
1987	51.1	"The Engineer shall make any variation of the **form, quality** or quantity of the Works or any part thereof that may, in his opinion**, be necessary and for that purpose**, or if for any other reason it shall, in his opinion**, be appropriate**, he shall have the authority to instruct the Contractor to do and the Contractor shall do any of the following: (a) increase or decrease the quantity of any work included in the Contract, (b) omit any such work (but not if the omitted work is to be carried out by the Employer or any other contractor), (c) change the character or quality or kind of any such work, (d) change the levels, lines, positions and dimensions of any part of the Works, (e) execute additional work of any kind necessary for the completion of the Works, (f) change any specified sequence or timing of construction of any part of the Works. **No such variation shall in any way vitiate or invalidate the Contract**, but the effect, if any, of all such variations shall be valued in accordance with Clause 52 . . . ."	● Instructed variations shall be necessary and appropriate
1999	13.1	"Variations may be initiated by the Engineer at any time prior to issuing the Taking-Over Certificate for the Works, either by an instruction or by a request for the Contractor to submit a proposal. The Contractor shall execute and be bound by each Variation . . . Each Variation may include: (a) changes to the quantities of any item of work included in the Contract (however, such changes do not necessarily constitute a Variation), (b) changes to the quality and other characteristics of any item of work, (c) changes to the levels, positions and/or dimensions of any part of the Works, (d) omission of any work unless it is to be carried out by others, (e) any additional work, Plant, Materials or services **necessary for the Permanent Works**, including any associated Tests on Completion, boreholes and other testing and exploratory work, or (f) changes to the sequence or timing of the execution of the Works. The Contractor shall not make any alteration and/or modification of the Permanent Works, unless and until the Engineer instructs or approves a Variation."	● None of the items in sub-clause 13.1 contemplates any substantial departure from the original scope of the works. The first two sentences of FIDIC 1987 - explicitly stating that the instructed variations shall be necessary and appropriate - were deleted. However, the statement “necessary for the Permanent Works” corroborates the fact that variations shall be necessary and within the scope of the permanent works.

2017	13.1	"Variations may be initiated by the Engineer under Sub-Clause 13.3 [Variation Procedure] at any time before the issue of the Taking-Over Certificate for the Works. Other than as stated under Sub-Clause 11.4 [Failure to Remedy Defects], a Variation shall not comprise the omission of any work which is to be carried out by the Employer or by others unless otherwise agreed by the Parties. The Contractor shall be bound by each Variation instructed under Sub-Clause 13.3.1 [Variation by Instruction], and shall execute the Variation with due expedition and without delay, unless the Contractor promptly gives a Notice to the Engineer stating (with detailed supporting particulars) that: (a**) the varied work was Unforeseeable having regard to the scope and nature of the Works described in the Specification;** (b) the Contractor cannot readily obtain the Goods required for the Variation; or (c) it will adversely affect the Contractor's ability to comply with Sub-Clause 4.8 [Health and Safety Obligations] and/or Sub-Clause 4.18 [Protection of the Environment]. Promptly after receiving this Notice, the Engineer shall respond by giving a Notice to the Contractor cancelling, confirming or varying the instruction. Any instruction so confirmed or varied shall be taken as an instruction under Sub-Clause 13.3.1 [Variation by instruction]. Each Variation may include: (i) changes to the quantities of any item of work included in the Contract (however, such changes do not necessarily constitute a Variation); (ii) changes to the quality and other characteristics of any item of work; (iii) changes to the levels, positions and/or dimensions of any part of the Works; (iv) the omission of any work, unless it is to be carried out by others without the agreement of the Parties; (v) **any additional work, Plant, Materials or services necessary for the Permanent Works,** including any associated Tests on Completion, boreholes and other testing and exploratory work; or (vi) changes to the sequence or timing of the execution of the Works. The Contractor shall not make any alteration to and/or modification of the Permanent Works, unless and until the Engineer instructs a Variation under Sub-Clause 13.3.1 [Variation by Instruction]."	● The contractor is given the right to object on any variation if "the varied work was Unforeseeable having regard to the scope and nature of the Works described in the Specifications"; somehow targets the concept of cardinal changes to the works and the contractor can upon "promptly" giving a notice to the engineer object on a certain variation that is considered outside the latter's scope of work and the engineer must also respond "promptly". Moreover, the statement "necessary for the Permanent Works" corroborates that any variation shall not vitiate the original scope of the works.

Table 9: FIDIC standard forms of Contract - Clauses Dealing with Volume of Changes

FIDIC Standard Form	Sub-Clause Reference	Wording of Sub-Clause(s)	Remark(s)
Criteria 2: Volume of Change			
1987	52.2 - 52.3	● **Sub-Clause 52.2:** "Provided that if the nature **or amount of any varied work relative to the nature or amount of the whole of the Works or to any part thereof,** is such that, in the opinion of the Engineer, the rate or price contained in the Contract for any item of the Works is**, by reason of such varied work, rendered inappropriate or inapplicable**, then, after due consultation by the Engineer with the Employer and the Contractor, a suitable rate or price shall be agreed upon between the Engineer and the Contractor. . . Provided also that no varied work instructed to be done by the Engineer pursuant to Clause 51 shall be valued under Sub-Clause 52.1 or under this Sub-Clause unless, within 14 days of the date of such instruction and, other than in the case of omitted work, before the commencement of the varied work, notice shall have been given either: (a) by the Contractor to the Engineer of his intention to claim extra payment or a varied rate or price, or (b) by the Engineer to the Contractor of his intention to vary a rate or price." ● **Sub-Clause 52.3:** **"**If, on the issue of the Taking-Over Certificate for the whole of the Works, it is found that as a result of: (a) all varied work valued under Sub-Clauses 52.1 and 52.2, and (b) all adjustments upon measurement of the estimated quantities set out in the Bill of Quantities, excluding Provisional Sums, dayworks and adjustments of price made under Clause 70, but not from any other cause**, there have been additions to or deductions from the Contract Price which taken together are in excess of 15 per cent of the "Effective Contract Price"** (which for the purposes of this Sub- Clause shall mean the Contract Price, excluding Provisional Sums and allowance for dayworks, if any) then and in such event (subject to any action already taken under any other Sub-Clause of this Clause), after due consultation by the Engineer with the Employer and the Contractor, **there shall be added to or deducted from the Contract Price such further sum as may be agreed between the Contractor and the Engineer or, failing agreement, determined by the Engineer having regard to the Contractor's Site and general overhead costs of the Contract.** The Engineer shall notify the Contractor of any determination made under this Sub-Clause, with a copy to the Employer. **Such sum shall be based only on the amount by which such additions or deductions shall be in excess of 15 per cent of the Effective Contract Price."**	● Acknowledges that the volume of change matters and that there exists a cumulative impact of change orders/variations

1999	12.3	" . . . For each item of work, the appropriate rate or price for the item shall be the rate or price specified for such item in the Contract or, if there is no such item, specified for similar work. **However, a new rate or price shall be appropriate for an item of work if:** (**a) (i) the measured quantity of the item is changed by more than 10% from the quantity of this item in the Bill of Quantities or other Schedule,** **(ii) this change in quantity multiplied by such specified rate for this item exceeds 0.01% of the Accepted Contract Amount,** **(iii) this change in quantity directly changes the Cost per unit quantity of this item by more than 1%,** and (iv) this item is not specified in the Contract as a "fixed rate item"; or (b) (i) the work is instructed under Clause 13 [Variations and Adjustments], (ii) no rate or price is specified in the Contract for this item, and (iii) no specified rate or price is appropriate because the item of work is not of similar character, or is not executed under similar conditions, as any item in the Contract. Each new rate or price shall be derived from any relevant rates or prices in the Contract, with reasonable adjustments to take account of the matters described in sub-paragraph (a) and/or (b), as applicable. If no rates or prices are relevant for the derivation of a new rate or price, it shall be derived from the reasonable Cost of executing the work, together with reasonable profit, taking account of any other relevant matters. Until such time as an appropriate rate or price is agreed or determined, the Engineer shall determine a provisional rate or price for the purposes of Interim Payment Certificates."	● Does not explicitly mention the "volume of changes"; the issue of the "volume of additional work" was implicitly targeted knowing that the contractor can claim a new rate under sub-clause 12.3 on the basis of additional quantities.

2017	12.3	" . . A new rate or price shall be appropriate for an item of work if: (a) the item is not identified in, and no rate or price for this item is specified in, the Bill of Quantities or other Schedule and no specified rate or price is appropriate because the item of work is not of similar character, or is not executed under similar conditions, as any item in the Contract; (b**) (i) the measured quantity of the item is changed by more than 10% from the quantity of this item in the Bill of Quantities or other Schedule,** **(ii) this change in quantity multiplied by the rate or price specified in the Bill of Quantities or other Schedule for this item exceeds 0.01% of the Accepted Contract Amount,** **(iii) this change in quantity directly changes the Cost per unit quantity of this item by more than 1%, and** (iv) this item is not specified in the Bill of Quantities or other Schedule as a "fixed rate item", "fixed charge" or similar term referring to a rate or price which is not subject to adjustment for any change in quantity; and/or (c) the work is instructed under Clause 13 [Variations and Adjustments] and sub-paragraph (a) or (b) above applies. Each new rate or price shall be derived from any relevant rates or prices specified in the Bill of Quantities or other Schedule, with reasonable adjustments to take account of the matters described in sub-paragraph (a), (b) and/or (c), as applicable. If no specified rates or prices are relevant for the derivation of a new rate or price, it shall be derived from the reasonable Cost of executing the work, together with the applicable percentage for profit stated in the Contract Data (if not stated, five percent (5%)), taking account of any other relevant matters. If, for any item of work, the Engineer and the Contractor are unable to agree the appropriate rate or price, then the Contractor shall give a Notice to the Engineer setting out the reasons why the Contractor disagrees. After receiving a Contractor's Notice under this Sub-Clause, unless at that time such rate or price is already subject to the last paragraph of Sub-Clause 13.3.1 [Variation by Instruction], the Engineer shall: • proceed under Sub-Clause 3.7 [Agreement or Determination] to agree or determine the appropriate rate or price; and • for the purpose of Sub-Clause 3.7.3 [Time limits], the date on which the Engineer receives the Contractor's Notice shall be the date of commencement of the time limit for agreement under Sub-Clause 3.7.3. Until such time as an appropriate rate or price is agreed or determined, the Engineer shall assess a provisional rate or price for the purposes of Interim Payment Certificates."	● Does not explicitly mention the "volume of changes"; the issue of the "volume of additional work" was implicitly targeted knowing that the contractor can claim a new rate under sub-clause 12.3 on the basis of additional quantities.

Table 10: FIDIC standard forms of Contract - Clauses Dealing with Cumulative Impact of Changes

FIDIC Standard Form	Sub-Clause Reference	Wording of Sub-Clause(s)	Remark(s)
Criteria 3: Cumulative impact of change			
1987	52.2 52.3	Refer to the wording here above	● Not explicitly stated whether the "net impact" or the "absolute impact" shall be taken into account which might be a subject of different interpretations and perspectives by the contracting parties. ●The 14-day notice requirement imposed under sub-clause 52.2 might result in the contractor's waiver/failure to recover impacts not readily foreseeable. ● It can be evident that the major aim of sub-clause 52.3 refers to the situation when the total effect (volume) of all variations results in an increase or decrease of more than 15% knowing that it is possible that each variation – if taken alone – might not have had a significant impact on the contractor's overhead; however, these variations, if looked at collectively, might have a substantial impact on the latter.

1999	13.3	"If the Engineer requests a proposal, prior to instructing a Variation, the Contractor shall respond in writing as soon as practicable, either by giving reasons why he cannot comply (if this is the case) or by submitting: (a) a description of the proposed work to be performed and a programme for its execution, (b) the Contractor's proposal for any necessary modifications to the programme according to Sub-Clause 8.3 [Programme] and to the Time for Completion, and (c) the Contractor's proposal for evaluation of the Variation. . . . Each instruction to execute a Variation, with any requirements for the recording of Costs, shall be issued by the Engineer to the Contractor, who shall acknowledge receipt. **Each Variation shall be evaluated in accordance with Clause 12 [Measurement and Evaluation], unless the Engineer instructs or approves otherwise in accordance with this Clause."**	Nothing is mentioned regarding the contractor's ability to recover unforeseen cumulative impacts resulting from the large number of changer orders after having agreed as to the individual impact of each change order. The cumulative impact of changes is not addressed in any clause even in Clause 17 [Risk and Responsibility]
2017	13.3	13.3.1 Variation by Instruction "The Engineer may instruct a Variation . . . The Contractor shall proceed with execution of the Variation and shall within 28 days (or other period proposed by the Contractor and agreed by the Engineer) of receiving the Engineer's instruction, submit to the Engineer detailed particulars including: (a) a description of the varied work performed or to be performed, including details of the resources and methods adopted or to be adopted by the Contractor; (b) a programme for its execution and the Contractor's proposal for any necessary modifications (if any) to the Programme according to Sub-Clause 8.3 [Programme] and to the Time for Completion; and (c) **the Contractor's proposal for adjustment to the Contract Price by valuing the Variation in accordance with Clause 12 [Measurement and Valuation], with supporting particulars (which shall include identification of any estimated quantities and, if the Contractor incurs or will incur Cost as a result of any necessary modification to the Time for Completion, shall show the additional payment (if any) to which the Contractor considers that the Contractor is entitled).** If the Parties have agreed to the omission of any work which is to be carried out by others, the Contractor's proposal may also include the amount of any loss of profit and other losses and damages suffered (or to be suffered) by the Contractor as a result of the omission. . . The Engineer shall then proceed under Sub-Clause 3.7 [Agreement or Determination] to agree or determine: (i) EOT, if any; and/or (ii) **the adjustment to the Contract Price (including valuation of the Variation in accordance with Clause 12 [Measurement and Valuation] using measured quantities of the varied work) (and, for the purpose of Sub-Clause 3.7.3 [Time limits], the date the Engineer receives the Contractor's submission (including any requested further particulars) shall be the date of commencement of the time limit for agreement under Sub-Clause 3.7.3). The Contractor shall be entitled to such EOT and/or adjustment to the Contract Price, without any requirement to comply with Sub-Clause 20.2 [Claims For Payment and/or EOT].** 13.3.2 Variation by Request for Proposal The Engineer may request a proposal, before instructing a Variation, by giving a Notice (describing the proposed change) to the Contractor. The Contractor shall respond to this Notice as soon as practicable, by either: (a) submitting a proposal, which shall include the matters as described in sub-paragraphs (a) to (c) of Sub-Clause 13.3.1 [Variation by Instruction]; or (b) giving reasons why the Contractor cannot comply (if this is the case), by reference to the matters described in sub-paragraphs (a) to (c) of Sub-Clause 13.1 [Right to Vary]. If the Contractor submits a proposal, the Engineer shall, as soon as practicable after receiving it, respond by giving a Notice to the Contractor stating his/her consent or otherwise. . ."	Nothing is mentioned regarding the contractor's ability to recover unforeseen cumulative impacts resulting from the large number of changer orders after having agreed as to the individual impact of each change order. The cumulative impact of changes is not addressed in any clause even in Clause 17 [Care of Works and Indemnities]

Furthermore, the two explored case studies further fortify the fact that each party to the contract may take a different standpoint towards quantifying and assessing the volume of change orders. In case study 1, the contractor considered that the changes quantified to induce a cardinal change to the contract triggering clause 52.3 of the FIDIC 1987 standard form of contract while the employer/considered that the contractor's approach was very faulty and ill-founded. In case study 2, both parties had different perspectives with regards to expressing the volume and the cumulative impact of change orders. These two cases have encouraged this research in terms of (1) trying to formulate a clearer and solid criteria towards expressing the large volume of change orders and (2) trying to understand what quantifies to be considered as a cardinal change to the contract.

Accordingly, in the next two chapters, a closer analysis will be conducted on both, cumulative impact claims and cardinal change claims, to try to identify the success and failure criteria of the same along with the different legal repercussions related to the aforementioned. The aim of the analysis is to try to deduce what has been accepted by courts and to establish a benchmark that can assist contractors and employers as to the viability and the admissibility of such claims based on a case law review rather than a subjective perspective that might be corrupted and/or ill-founded.

CHAPTER 4

CUMULATIVE IMPACT CLAIMS

4.1 Introduction:

Cumulative impacts are one of the most misunderstood theories in the construction industry. In the case of construction projects that experience a substantial number of change orders, cumulative impact claims have become one fall back for contractors to attempt to recover monies and losses on unsuccessful projects (Popescu et. al, 2007).

Generally, for each change the contractor is entitled to an equitable adjustment to the contract price and time for completion for all productivity impacts associated with the change (Hanna and Swanson, 2007).

In large and complex construction projects experiencing multiple change orders, these changes may act concurrently and in sequence resulting in a synergistic effect upon the base work (Backus, 2010). When multiple change orders are involved impacting different parts in the project, the contractor's ability to take meaningful mitigation steps might be jeopardized resulting in large disruptions to the flow of the works. Such disruptions result in lost productivity and inefficiencies (Jones, 2003). Cumulative impacts have been exceedingly difficult to prove and had been an ill-defended concept (Leonard, 1988).

Nonetheless, there seems to be a significant gap and inconsistency in the literature in terms of defining cumulative impacts and clearly deducing what is necessary for maintaining such a claim. Despite acknowledging and recognizing the existence of cumulative impact claims resulting from the large number of change orders, at least one board has stated that this concept is “somewhat amorphous” (Centex Bateson Construction Co. v. West (2000)).

Accordingly, this chapter aims at clearly defining cumulative impacts resulting from the large number of change orders, analyzing the development of legal principles with regards to the same, deducing the criteria for the success and failure of cumulative impact claims after conducting a case law review, and extracting key insights from the investigated literature.

4.2 Definitions

After a thorough examination of the literature, several definitions of a cumulative impact claim were obtained and summarized vide Table 11.

Table 11: Definition of Cumulative Impact Claim

No	Definition(s)	Reference
1	“The Overall concept of cumulative impact is that with the large number of change orders on more complex construction projects, a contractor has less ability to control productivity. The contractor only realizes the impact through a retrospective analysis.”	Frey, W., 2006. Change orders have a cumulative impact. *Journal of Commerce*, 46, p.1.
2	“A cumulative impact of change orders occurs when “the issuance of an unreasonable number or unusual kind of change orders creates a synergistic disruptive impact such that the total disruption caused by the changes exceeds the sum of the disruptive impacts caused by the individual change orders when looked at independently” Finke 1997 .	Hanna, A. S., and Swanson, J. (2007). “Risk Allocation by Law—Cumulative Impact of Change Orders.” Journal of Professional Issues in Engineering Education and Practice, 133(1), 60–66.

3	1- "Cumulative impact" is the disruption occurring between two or more change orders and basic work, but does not include local disruption directly attributable to a specific change order." 2- "The cumulative impact claim is the aftermath of the inability of the contractor to accurately account for all impact costs resulting from the multiplicity of change orders, including costs not associated with any particular change." 3- "Cumulative impact costs are "costs associated with impact on distant work, and are not as readily foreseeable or, if foreseeable, as readily computable as direct impact costs. The source of such costs is the sheer number and scope of the changes to the contract." 4- " The source of cumulative impact loss is not simply "a series of mere isolated hardships, but rather the Gestalt principle of many problems occurring concurrently--with devastating impact on performance greater than the numerical sum of the parts." 5-"It is the synergistic effect of changes on the unchanged work and on other changes." 6- "A critical condition precedent to the allowance of cumulative disruption costs is a showing that they relate to excessive and frequent design or structural changes the impact of which were distant and unforeseeable during the pricing of proposals and negotiations for direct costs." 7-"Cumulative impact need not be traced to specific causes of increased performance costs, but can arise from changes which, when viewed retrospectively, were so many and had such effect on performance that there is a separately compensable impact claim." 8-"Cumulative impact is referred to as the 'ripple effect' of changes on unchanged work that causes a decrease in productivity and is not analyzed in terms of spatial or temporal relationships."	Backus, L. E. (2010). "The Cumulative Impact Claim: Where Do We Stand In 2010" Defense Counsel Journal, 206.
4	1. "The costs associated with impact on distance work, and are not readily foreseeable or, if foreseeable, are not ready computable as direct impact costs. The source of such costs is the sheer number and scope of the changes to the contract. The result is an unanticipated loss of efficiency and productivity which usually extends the contractor's stay on the job" (Pittman Construction, GSBCA Nos. 4897, 4923, 81-1 BCA 14,847).	Hanna, A. S., and Iskandar, K. A. (2017). "Quantifying and Modeling the Cumulative Impact of Change Orders." Journal of Construction Engineering and Management, 143(10), 04017076.

5	1. “Cumulative impact refers to the fact that the contractor is unable to predict the unforeseen impact of changes on other areas of work (unchanged work).” 2. “Cumulative impact occurs when multiple or unusual changes are ordered, resulting in more productivity losses than the sum of each individual change impact due to the ripple effect of changed work.” 3. “Cumulative impact is the unforeseeable disruption of productivity resulting from the ‘synergistic’ effect of an undifferentiated group of changes. Cumulative impact is referred to as the ‘ripple effect’ of changes on unchanged work that causes a decrease in productivity and is not analyzed in terms of spatial or temporal relationships." - Centex Bateson Construction Co. (VABCA, 1999) 4. “Cumulative Impact Costs definition: Cumulative impact costs are the costs associated with impact on distant work that are not as readily foreseeable or, if foreseeable, not as readily computable as direct impact costs. The source of such costs is the sheer number of and scope of changes to the contract. The result is an unanticipated loss of efficiency and productivity which increases the contractor’s performance costs and usually extends his stay on the job.”	Lee, M.-J. (2002). Artificial Intelligence Approach To Classify And Quantify Cumulative Impact Of Change Orders On Labor Productivity.
6	1. “Cumulative impact might indicate that it is a term commonly used in the construction industry to describe the adverse financial effect of two or more unforeseeable changes on a project, the effect and quantum of such to be proven by the project’s contemporaneous documents.” 2. “Cumulative impact is the unforeseeable disruption of productivity resulting from the “synergistic” effect of an undifferentiated group of changes. Cumulative impact is also known as the “ripple effect” of changes on unchanged work that causes a decrease in productivity and is not analyzed in terms of spatial or temporal relationships. This effect is unforeseeable and indirect.” 3. By definition, cumulative impacts manifest themselves in two ways. First, as productivity disruption from “the synergistic effect of an undifferentiated group of changes,” which addresses direct costs whose spatial and temporal relationships to the changed work matter. Second, but conversely, reduced productivity due to “ripple effect of changed work on the unchanged work.”	Popescu, A., and Ottesen, J. (2007). "How to Prove/Disprove "Cumulative Impact" Claims". AACE International Transactions.
7	“Local [or direct] disruption” refers to the direct impact that changed work has on other unchanged work going on around it. Conceptually, for purposes of this appeal “cumulative disruption” is the disruption that occurs between two or more change orders and basic work and is exclusive of the local disruption that can be ascribed to a specific change. It is the synergistic effect… of changes on the unchanged work and on other changes.”	Long, R.J., and Carter, R.C (2012). “Cumulative Impact Claims”. Long International, Inc.

According to the above, and by definition, it can be deduced that cumulative impacts resulting from the substantial number of change orders are losses that:

- Are a result of the synergistic disruptive impacts (ripple effect) such that the total disruption caused by the changes exceeds the sum of the disruptive impacts caused by the individual change orders when looked at independently.
- Result in costs associated with impact on distant or unchanged work. Such costs are not readily foreseeable and/or if foreseeable not as readily computable as direct impact costs.
- Result in unanticipated loss in efficiency and productivity and is not analyzed in terms of spatial or temporal relationships which increases the contractor's performance costs and usually extends his stay on the job.

4.2 Evolution of Historical Principles

Present-day cumulative impact claims (hereafter referred to CI claims) are a result of the development of legal principles over the years. These principles were summarized vide Table 12 below and the basis of each is elaborated here below.

Table 12: Development of Legal Principles Related to Cumulative Impact Claims

	Principle	Source	Time Frame	Case Law
Principle 1	"Mathematical exactitude in quantifying damages is not required for recovery."	Common Law	1951-1965	● Houston Ready-Cut House Co. v. United States, 96 F. Supp. 629, 119 Ct.Cl. 120 (1951). ● Locke v. United States, 283 F.2d 521, 151 Ct.Cl. 262 (1960) ● Missouri State Supreme Court case Schwartz v. Shelby Construction Company (1960) ● Dale Construction Co. v. United States, No. 134-57, Ct.Cl., December 11, (1964); ● J.D. Hedin Construction Co., Inc. v. United States, Ct.Cl., 347 F.2d 235, 246-247 (1965)."
Principle 2	"Absent fraud, capriciousness or grossly erroneous bad faith, the contract is the basis for final resolution and remedies for relief of disputes between contracting parties."	Common Law	1954	● Wunderlich Contracting Co. v. United States, 351 F.2d 956 (1954) ● Banks Construction Company v. United States, 364 F.2d 357, 1965).
Principle 3	"For a cumulative claim to be successful, the contractor shall prove that a cardinal change has been established."	Common Law	1955	F. H. McGraw and Co. v. United States 130 F.Supp., 394, (Ct Cl. 1955)

Principle 4	"Changes and costs imposed on the contractor by the employer must be differentiated from changes and costs incurred from other factors unrelated to the employer."	Common Law	1961-1964	● Saddler v. United States, 287 F.2d 411, 152 Ct.Cl. 557, 561 (1961) ● Aragona Construction Co., Inc. v. United States, No. 435-59, Ct.Cl., April 17, 1964. ● Appeal of Wunderlich Contracting Co. v. United States, 351 F.2d 956 (1965)
Principle 5	"Foreseeability of changes limits recovery for performing changed work later."	Common Law	1965	● Appeal of Wunderlich Contracting Co. v. United States, 351 F.2d 956 (1965) ● Freund v. United States, 260 U.S. 60 (1922)
Principle 6	"There is no exact formula for determining the point at which a single change or a series of changes must be considered to be beyond the scope of the contract and necessarily in breach of it."	Common Law	1965	● Appeal of Wunderlich Contracting Co. v. United States, 351 F.2d 956 (1965)
Principle 7	"Cumulative Impact need not to rise to the level of a cardinal change."	Common Law	1983	Pittman Construction Co. v. United States (GSBCA Nos.4897, 4923, 81-1 BCA)

Principle 8	"Recovery via cumulative impact claim is possible only if not precluded by contract."	Common Law	1991-2006	● Atlantic Dry Dock Corp. v. U.S., (M.D.Fla. 1991) 773 F. Supp. 335 ● Jackson Construction Co., Inc. v. U.S., (Fed.Cl.2004) ● Magnolia Constr. v. Parish of St. Charles, 06-543 (La.App. 5 Cir. November, 28, 2006).
Principal 9	"Cumulative impact can be viewed as a separate constructive change under the changes clause that gave rise to cumulative impact costs"	Common Law	2000	Centex Bateson Constr. Co. v. West, 250 F.3d 761 (2000)

The above are the summarized results of a study conducted by Popescu et al. (2007) that examined the history of cumulative impact principles. The latter's research encompassed the most primitive forms of the law established by the Hebrew scripture and the written code of Hammurabi and the most developed systems of the law including civil law and common law. Critical scrutiny and attention was given to case law that represented a major shift in the courts' approach and decisions with respect to CI claims.

Pursuant to the common law system, it is evident that courts have improved and changed their approach and decisions regarding cumulative impact claims. The latter was fortified by a review of case law conducted by Popescu et al. (2007) which involved the examination of earliest and the latest recorded examples of cumulative impact claims and consequently comparing and analyzing the evolvement of legal principles between these two reference points. More that seventy cases were considered to have contributed to the core genesis of cumulative impact claims. In many reviewed cases, it was found that when the contractor has followed the provisions of the contract but disagreed with the employer's/engineer's quantum, the court's decision was awarded in favor of the contractor if the latter was able to successfully prove that the incurred expenses were directly as a result of the incurred changes.

In 1954, a crucial court ruling was considered as having established standards based on which cumulative impact claims are being dealt with today. These standards were as a result of a dispute between Wunderlich, Curlett & Topkins, acting as a joint venture general contractor, and the U.S government. The project was related to the erection of a 500-bed hospital complex in Salt Lake City at Utah. The contractor experienced numerous disruptions that resulted in escalated costs and in a delay of 318 days in the completion of the works. The contractor’s claim was based on the below three theories:

- Quantum Meruit, that is based on the fact that a plaintiff must be reimbursed and entitled to reasonable costs related to the defendant issuance of an unreasonable amount of variations to the works. The contractor claimed that the cumulative effect of the substantial amount of variation orders has resulted in a fundamental alteration to the contemplated scope of work under the contract. The term “Quantum Meruit” is a Latin term meaning “as much as he deserved”; or in other words, the actual costs of the services performed. The Quantum Meruit principle is generally used in the absence of a contract between the parties whenever works expecting payment were performed.
- Equitable Adjustment under the provision related to the suspension of works under the contract. The contractor asserted that the contract specification and furnished plans were extremely ambiguous. The latter, coupled with the fact of experiencing a substantial number of changes, must have necessitated the suspension of the works in order to make all the necessary corrections and prevent potential delays and expenses on behalf of the contractor.
- Damage of breach of contract based upon the contractor’s allegation that the employer knowingly provided it with specifications, plans, and instructions that were ambiguous and incomplete hindering any performance.

In this case the contractor used the cumulative impact as the bases for Quantum

Meruit and equitable adjustment. However, the contractor lost the case and the appeal, for the reasons listed here below. Notwithstanding, several core principles were established in this case what was afterwards known as the “Wunderlich act”. From the appeal of Wunderlich Contracting Co. v. United States, 351 F.2d 956 (1965), many principles were cited in regards to how the contractor has failed to establish its cumulative impact claim (Principles 1, 2 , 3, 4, 5 and 6 in Table 12).

Principle 5 was based on the following quoted ruling: “The existence of many errors, omissions, and discrepancies in the plans and drawings for the project would have been obvious to any competent person who examined them, and in the course of the proceedings several mistakes were brought to the attention of defendant and were later corrected by addenda. Although plaintiffs were present at this meeting, they did not comment at the time on any of the apparent deficiencies and errors in the documents.” Thus, because errors were known, or should have been known at the contract onset, Wunderlich was not able to recover solely on argument of the large number of changes. This ruling was consistent with an earlier case in 1922 (Freund v. United States, 260 U.S. 60) where the court held that the changed work is considered to be within the general scope if it “should be regarded as having been fairly and reasonably within the contemplation of the parties when the contract was entered into.” It was further stated that “[e]ach case must be analyzed on its own facts and in light of its own circumstances, giving just consideration to the magnitude and quality of the changes ordered and their cumulative effect upon the project as a whole. Saddler v. United States, 287 F.2d 411, 152 Ct.Cl. 557, 561 (1961). The contractor cannot claim a breach of the contract if the project ultimately constructed is essentially the same as the one it agreed in the contract to erect. Aragona Construction Co., Inc. v. United States, No.

435-59, Ct.Cl. April 17, 1964." The case also states that the "plaintiffs have failed to allocate between costs of performing extra work in accordance with the changes and costs unavoidably incurred as a result of alien factors. . . [Plaintiffs] stand on the basic unproved assertion that defendant was responsible for all losses on the contract. . . Plaintiffs have been compensated by price adjustments for the verified costs of carrying out these alterations, and have not shown by a preponderance of the evidence that they are entitled to any additional sum…[a] claimant need not prove his damages with absolute certainty or mathematical exactitude. Dale Construction Co. v. United States, No. 134-57, Ct.Cl., December 11, 1964; Houston Ready-Cut House Co. v. United States, 96 F. Supp. 629, 119 Ct.Cl. 120 (1951). It is sufficient if he furnishes the court with a reasonable basis for computation, even though the result is only approximate. F.H. McGraw & Co. v. United States, supra; Locke v. United States, 283 F.2d 521, 151 Ct.Cl. 262 (1960). Yet this leniency as to the actual mechanics of computation does not relieve the contractor of his essential burden of establishing the fundamental facts of liability, causation, and resultant injury. River Construction Corp. v. United States, 159 Ct.Cl. 254 (1962); Addison Miller, Inc. v. United States, 70 F. Supp. 893, 108 Ct.Cl. 513 (1947), cert. denied, 332 U.S. 836, 68 S.Ct. 217, 92 L.Ed. 408 (1947); J.D. Hedin Construction Co., Inc. v. United States, Ct.Cl., 347 F.2d 235, 246-247 (1965)."

Notwithstanding the above, generally most if not all contractors, agree that is nearly impossible to track every dollar spent on changed works; however, the same can be simply mitigated by maintaining effective documentation.

Principle 1 was further supported by the court's ruling on Missouri State Supreme Court case Schwartz [subcontractor] v. Shelby Construction Company [prime contractor] whereby the plaintiff sought remedy under the common law quantum meruit principle arguing that the substantial number of change orders has constituted a cardinal change under the contract. In this case the plaintiff was entitled only for documented costs that could be directly related to the defendant actions.

In Atlantic Dry Dock Corp. v. U.S., (M.D.Fla. 1991) 773 F. Supp. 335, the government won the case based on the signed contract language and stipulations whereby the court indicated that "Examining the language of the release provision, the court first notes that its terms are couched in the plural; the release is applicable to "delays and disruptions resulting from, caused by, or incident to such modifications or change orders"."

The U.S court of Federal Claims and the different boards of contract appeals have recognized contractors' rights to collect for cumulative impact costs resulting from the substantial number of employer-instructed changes (Jones, 2003). Notwithstanding, the court's ruling and case law showed that there had been no general or definite rule that the judicial system use/comprehend to determine whether or not a contractor's claim for cumulative impact costs are due or not.

Firstly**,** courts have held that for a cumulative impact claim to be successful, the contractor shall prove that a cardinal change has been established. However, in recent cases, courts have come to rule on the viability of cumulative impact claims on the basis of a constructive change. Notwithstanding, some courts have construed cardinal change as directly resulting in abandonment of contract. The court set out two approaches to determine the viability of a cumulative impact case. According to Hanna and Swanson (2007), most case law fell under one of two main categories: (1) cumulative impact that is greater than the sum of changes ensuing it, yet not large enough to constitute a cardinal change, and (2) cumulative impact rising to the level of cardinal change. These situations were set out in Pittman Construction Co. v. United States (GSBCA Nos.4897, 4923, 81-1 BCA at 73,297) as being the two most common approaches taken by courts to determine the viability of a cumulative impact claim.

Recently the industry has held that there is no need to prove that a cardinal change has been established in order to prove a cumulative impact claim (Keating, 2000; Fitzegarld, 2002; Backus, 2003). In the last couple of decades, courts decisions have gradually shifted the basis of establishing a cumulative impact claim from proving that a cardinal change has been established to simply proving that the contractor has experienced a large number of constructive change (Jones, 2001). In Centex Bateson Constr. Co. v. West, 250 F.3d 761 (2000), the court stated that the cumulative impact could be viewed as a separate constructive change under the changes clause that gave rise to cumulative impact costs:

"Although there is no need to engage in a pre-Contract Disputes Act analysis of whether cumulative impact is a separate constructive change or a cardinal change in order to preserve our jurisdiction, it seems to us that cumulative impact must be viewed as a separate constructive change under the CHANGES clause. This constructive change, although resulting from them, is independent of other contract changes and can survive an accord and satisfaction on a change, or a general release" (Centex Bateson Constr. Co. v. West, 250 F.3d 761 (200)). However, courts decision have been confusing and sometimes unclear as to whether the decision was based using the constructive change concepts or the cardinal change concepts. In L. K. Comstock & Co. v. Becon Constr. Co. (932 F.Supp. 906, 931, E.D. Ky. 1993), the court declared that either a cardinal change or a constructive change can be utilized to: "establish a basis for recovery outside the original contract in cases where the contractual obligations of a construction contractor vary materially from the original expectations of the parties regarding the scope and manner of work."

It seems that, to date, courts have been struggling trying to determine whether or not the changes to the works have established a cardinal change.

4.3 Success and Failure Criteria: Legal Perspective

4.3.1 Case Law Review

For the purpose of identifying the success and failure criteria pertaining to cumulative impact claims resulting from the substantial amount of change orders, a case law review was conducted and cases where analyzed to deduce the major set of the said criteria along with the frequency of each in the analyzed cases.

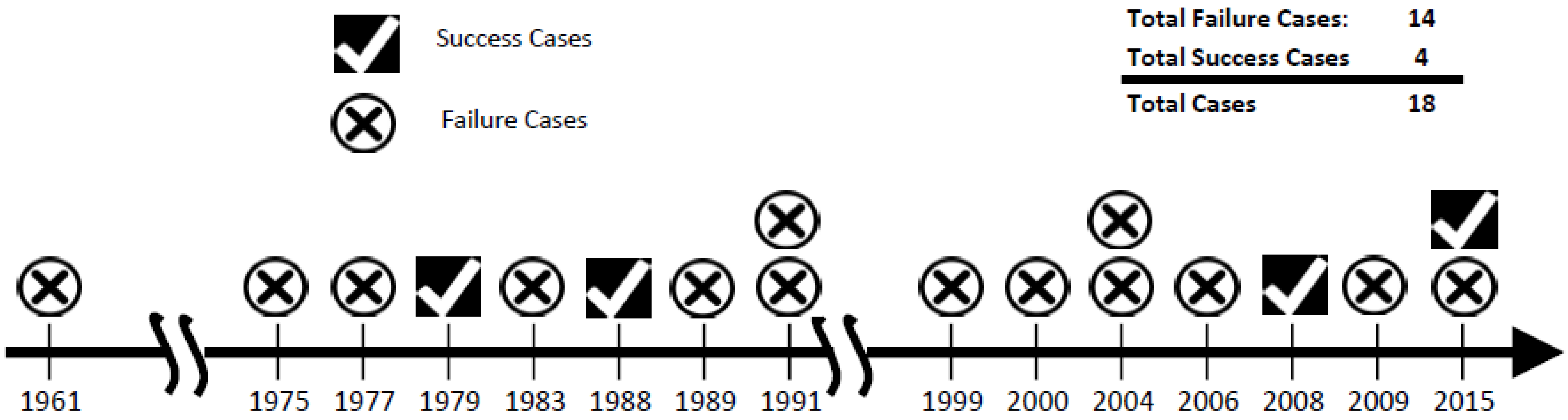

Figure 8: Timeline of Analyzed Case

Table 13: Case Law related to Cumulative Impact Claims

Case Code	Case Name	Year	Court Ruling	Dispute between: [“( )” Identifies the party for which the ruling was in favor of]	Status	Success/Failure Criteria
C1	Oberer Constr. Co. v. Park Plaza, Inc.	1961	The accepted law is that: “An employer commits a breach of a construction contract by changing plans and specifications otherwise than the contract permits and ordering substituted performance. . . A change that is wrongfully required may involve so great delay or expense as to amount to a total breach as a practical repudiation of the construction contract. An assent by the contractor and proceeding with the work as demanded, **without reservation of rights, will operate as a variation of the original contract leaving no claim for damages”**	(Employer) v. Contractor	Failed	**● FC6: Contractor failed to submit a notice to reserve its right to collect cumulative impact at a later date.**

C2	Watt Plumbing, Air Conditioning & Electric Inc. v. Tulsa Rig, Reel & Manufacturing Co., 533 P.2d 980	1975	"Watt filed a Response to the motion and an amendment to the Response. Watt alleged that the changes were so abnormal, excessive, inordinate, and not within the contemplation of the parties at the time the contract was executed, that they represented a cardinal change **The order found that there was not substantial dispute as to the facts, and that as a matter of law the approved changes performed by Watt did not constitute of themselves a breach of the subcontract, because Watt had separately agreed to perform each change for an agreed price. The court also concluded that the cardinal change doctrine was not applicable where the subcontractor agrees to perform for an agreed price the changes alleged to constitute a cardinal change** **It is axiomatic that by mutual assent parties to an existing contract may subsequently enter into a valid contract to modify the former contract provided there is consideration for the new agreement. An alteration of a contract cannot constitute a breach of contract because it becomes a part of the contract. The contract as altered is the agreement between the parties."**	(Contractor) v. Subcontractor	Failed	**● FC1 :Contractor could not resort to the cardinal change doctrine knowing that it had entered into a new agreement to perform the works with an agreed price** **● FC5:Contract contained release language and/or barred the Contractor from collecting cumulative impact under the doctrine of accord and satisfaction**

C3	Huber, Hunt & Nichols v. Moore, 67 Cal.App.3rd 278 (1977);	1977	**“Contractor's position here and in the court below seems to be simply that although admittedly its computer operated accounting system did not distinguish in any manner between ordinary costs and alleged increased costs proximately caused by Architects' alleged negligence,** nevertheless since such computer accounting system was kept in accordance with standard business practices, Contractor . . . It was within Contractor's legal power to compute estimated change order costs in a manner which would compensate Contractor for its total loss. It failed to do so. Architects were not legally responsible for that failure. So far as we can tell from this record, Contractor was paid in almost every instance what Contractor requested on the 25 C.O.s issued. Contractor simply did not request enough on those C.O.s which were authorized. A factor of 10 percent or 15 percent for administration and overhead was obviously too low if Contractor's present claims are accurate.” **“We find no error in the trial court's refusal to allow Contractor to prove damage under the total cost concept.”**	(Employer) v. Contractor	Failed	**● FC2: Contractor has failed to prove causation and resultant injury** **● FC4: Contractor could not separate its impacts from employer/engineer caused impacts.**

C4	Pittman Construction Co. v. United States (GSBCA Nos.4897, 4923, 81-1 BCA)	1983	“The Cumulative Impact Claim: As noted in the preceding discussion, even though the board has found the contractor’s letters of no legal significance so far as the reservation of a direct impact cost claim was concerned, it did deem them sufficient to secure a claim for indirect or “cumulative” impact costs. Such costs, as the board defined them, addressed the inefficiencies and disruptions associated with changes which, when viewed cumulatively (i.e., retrospectively), were so large in number and/or magnitude as to give rise to a separately compensable impact claim. The term “ripple effect” has also been used to describe such impact costs.” “. . But even as the board was willing to endorse such costs conceptually and to recognize their survival (as a provable claim) on the facts of the case, **so it went on to find that the contractor had failed to prove entitlement to them.** Two grounds were given for this result. First, that in terms of their number and dollar value, the changes that were involved here (even when taken in the aggregate as opposed to counting only those affecting F & M’s and Babst’s work) were not enough to support the claimed costs. There had been 206 changes in this case which enlarged the contract’s dollar value by roughly 12 percent (they added $3,000,000 to a $25.6 million contract) and extended its performance period by approximately 10 percent (102 days were added to an original performance schedule of 1,000 days). These numbers, contrasted with the change dimensions noted in other cases in which cumulative impact claims had been considered**, led the board to conclude that no fundamental change in the character of the work had taken place and thus no costs had been experienced whose likelihood had not been foreseeable.”** “The second, but no less important ground for the board’s rejection of cumulative impact costs, was the fact that **the contractor’s evidence failed to take account of those delays and disruptions in the work that were traceable to the prime contractor’s own deviations in the planned construction sequence**.”	(Employer) v. Contractor	Failed	**● FC3: Contractor could not prove that a fundamental change in the character of the work had taken place and thus no costs had been experienced whose likelihood had not been foreseeable.** **● FC4: Contractor could not separate its impacts from employer caused impacts.**

C5	Appeal of Freeman-Darling, Inc., GSBCA No. 7112	1989	"**We are unpersuaded that the magnitude and accumulation of changes so significantly altered the contract as to create a claim for impact costs.**"	(Employer) v. Contractor	Failed	**● FC3: Contractor could not prove that a fundamental change in the character of the work had taken place and thus no costs had been experienced whose likelihood had not been foreseeable.**
C6	Atlantic Dry Dock Corp. v. United States, 773 F. Supp. 335 (1991)	1991	"The release provision contained in each modification includes a clause which clearly and specifically addresses delay and disruption, stating that the modification incorporates a final settlement of all claims arising out of each modification "including all claims for delays and disruptions resulting from, caused by, or incident to such modifications or change orders." A plain reading of this language convinces the Court that the only reasonable interpretation of **the release provision is that it was intended to resolve all claims for damages caused by delay and disruption, whether cumulative or otherwise. Therefore, the provision is unambiguous and bars plaintiff's claim as a matter of law."**	(Employer) v. Contractor	Failed	**● FC5: Contract contained release language that barred the Contractor from collecting cumulative impact under the doctrine of accord and satisfaction**
C7	JOHN MASSMAN CONTRACTING CO., Plaintiff v. The UNITED STATES, Defendant	1991	"Furthermore, the court is precluded from considering extrinsic evidence to vary the meaning of clear, unambiguous language. Id. Looking solely at the plain language of each of the first four contract modifications, and in light of the fact **that plaintiff executed each agreement without any reservation of claim for additional compensation**, **plaintiff's argument that the parties did not intend the modifications to provide "compensation in full" because there was no meeting of the minds must fail."** **"Plaintiff also must show that the actual conditions encountered were unforeseeable, and that its interpretation of the contract was reasonable."**	(Employer) v. Contractor	Failed	**● FC6: Contractor failed to submit a notice to reserve its right to collect cumulative impact at a later date.** **● FC7: Contractor failed to prove that impacts were unforeseeable**

C8	Fru-Con Constr. Corp. v. United States	1999	"Plaintiffs attempt to provide missing productivity information through, the testimony of its expert did not compensate. Dr. James J. Adrian focused his investigation on lost productivity. . . . **The court is unable to discern from Dr. Adrian's analysis a causal relationship between the weather and plaintiffs loss of productivity...**.Due to the lack of contemporaneous documentation, plaintiff failed to demonstrate that unusually severe weather affected its productivity, thereby resulting in an excusable delay over which plaintiff was constructively directed to accelerate. Accordingly, based on the foregoing, plaintiff has failed to prove its case by a preponderance of evidence. The Clerk of the Court shall enter judgment for defendant."	(Employer) v. Contractor	Failed	**● FC2: Contractor has failed to prove causation and resultant injury** **● FC8: Contractor failed to prove how the changes impacted its productivity (performance time and efficiency).**

C9	Centex Bateson Constr. Co. v. West, 250 F.3d 761	2000	"In looking at [contractor's] cumulative impact claim, we must keep in mind the fundamental triad of proof necessary to sustain a contractor's recovery for a constructive change giving rise to cumulative impact costs: liability, causation, and resultant injury." Although there is no need to engage in a pre-Contract Disputes Act analysis of whether cumulative impact is a separate constructive change or a cardinal change in order to preserve our jurisdiction, it seems to us that cumulative impact must be viewed as a separate constructive change under the CHANGES clause. This constructive change, although resulting from them, is independent of other contract changes and can survive an accord and satisfaction on a change, or a general release" "To find entitlement to cumulative impact damages here, we would have to find that an event involving changing the location of a light switch in a room in the east basement of VAMC Houston impacted the efficiency of all its work on the west side of the sixth floor simply because Dynalectric overran its labor projections for certain work activities for that month. The record simply does not support such a finding. " "...**proof of causation may take the form of demonstrating that there are no other reasons for a loss of productivity for which the Government is not responsible."**	(Employer) v. Contractor	Failed	**● FC2: Contractor has failed to prove causation and resultant injury**

C10	Jackson Construction Co. Inc. v. United States.	2004	". . . **An executed bilateral modification with a release provision usually constitutes an accord and satisfaction unless that release is either ambiguous or limited in scope** . . . A contractor may preserve its rights by explicitly reserving its rights to assert additional claims for the work covered by the modification . . . First, the Court rejects Jackson's argument that it explicitly reserved its rights to assert either a delay or a cumulative impact claim at a later date. . . . Therefore, **Jackson's cumulative impact claim (Count II) would still be barred by accord and satisfaction** . . . **Jackson's attempt to reserve its rights on either claim, however, is not valid because it was not made in a timely manner** . . . To be clear, the language utilized in Jackson's reservation of rights would have been sufficient to preserve at least its delay claim arising from the waterline work if it had been inserted into the earlier modification that settled Jackson's waterline claim . . **. Similarly, Jackson did not reserve its rights to assert future claims arising from any of the other specific performance problems that it presented at trial .** . . . The Court also rejects Jackson's argument that the release provisions were ambiguous and were procured through misrepresentation by the Corps . . . Finally, **Jackson has failed to meet its burden of proving that the modifications were executed under duress. While an agreement may be voided if it was procured by duress, "a party must show more than mere financial harm or economic tension" to prove duress.** . . . At trial, Jackso**n did not meet its burden of proving that it incurred additional damages resulting from the cumulative impact of the numerous changes to the Contract. Any contractor seeking an equitable adjustment from the Government must prove liability, causation, and resultant injury**. . . In order to recover on an impact claim, a contractor must do more than present evidence of the sheer number or scope of changes. **. . . Both Jackson's delay claim and its cumulative impact claim are barred by the doctrine of accord and satisfaction .** . ."	(Employer) v. Contractor	Failed	**● FC5: Contract contained release language that barred the Contractor from collecting cumulative impact under the doctrine of accord and satisfaction** **● FC2: Contractor has failed to prove causation and resultant injury** **● FC6: Contractor failed to submit a notice to reserve its right to collect cumulative impact at a later date.**

C11	J.A. JONES CONSTRUCTION COMPANY v. LEHRER McGOVERN BOVIS, INC.; and NATIONAL FIRE INSURANCE COMPANY OF HARTFORD,	2004	**"The contractor must prove facts with specificity that support its allegations that a cardinal change occurred.** . . .Indeed, while there is no precise calculus for determining whether a cardinal change has occurred, the courts have considered, inter alia, the following factors: (i) whether there is a significant change in the magnitude of work to be performed; (ii) whether the change is designed to procure a totally different item or drastically alter the quality, character, nature or type of work contemplated by the original contract; and (iii) whether the cost of the work ordered greatly exceeds the original contract cost **In this case, as LMB points out, the overall physical characteristics of Jones's work changed very little . . . The evidence required to demonstrate the occurrence of cardinal change is similar to that required by the contract-abandonment theory and, under these circumstances, it appears to us that Jones could also be entitled to relief on its claim under a theory of cardinal change. Consequently, the district court erred in dismissing this claim."**	Subcontractor v. (Contractor)	Failed	**● FC3: Contractor could not prove that a fundamental change in the character of the work had taken place and thus no costs had been experienced whose likelihood had not been foreseeable.** **● FC2: Contractor has failed to prove causation and resultant injury**
C12	Magnolia Constr. v. Parish of St. Charles, 06-543 (La.App. 5 Cir. November, 28, 2006).	2006	"The trial court disagreed with Magnolia's argument that it reserved its rights to claim indirect overhead expenses, and found that Magnolia "lost its right to bring further claims for "an increase in contract price and/or contract time when it entered into Change Order No. 1 and Change Order No. 2." The trial court further found that language in Change Order No. 3 "bars any indirect overhead claim Magnolia may have had under Change Order No. 1 or Change Order No. 2." . . . However, for a determination of whether such damages are due we are bound by the fundamental rules of contract . . . Those rules require the court to determine the common intent of the parties. When the words of a contract are clear and explicit and lead to no absurd consequences, no further interpretation may be made in search of the parties' intent. . . . Further, it is noted that the change order contains the following language: . . . The above language makes it clear that Magnolia received payment for all direct and indirect delay damages with the execution of this change order. . . . **those change orders constitute full and mutual accord and satisfaction."**	(Employer) v. Contractor	Failed	**● FC5: Contract contained release language that barred the Contractor from collecting cumulative impact under the doctrine of accord and satisfaction**

C13	AMEC CIVIL, LLC, Plaintiff, v. DMJM HARRIS, INC., Defendant/Third-Party Plaintiff, v. HARDESTY & HANOVER, LLP, Third-Party Defendant.	2009	"However, in the event that this Court finds that AMEC does use a modified total cost theory, then it argues that, as a matter of law, such a recovery theory is not barred in this case. Specifically, AMEC argues it satisfies prong one because it was highly impracticable to segregate the causes of its damages with any reliability because they were so interrelated **The plaintiff must prove that the delay was caused by the defendant and that the delay is compensable**. Id. A claimant, in the construction industry, must conduct a scheduling analysis of the project's schedules and logs based on corroborating evidence, such as vital records that reflect the costs it incurred relative to each asserted claim, to show that the delays affected activities on the critical path, which delayed the completion date of the project As discussed in the analysis of the total cost method, there are substantial questions regarding Plaintiff's ability to show causation, i.e. linking DMJM's alleged acts of negligence, filtered down through a ripple effect, to all damages AMEC allegedly suffered. See Part III.A., supra. On the other hand, Plaintiff's assertions that it will prove causation at trial, based upon representations that its experts will fully explain their analyses and adequately link AMEC's damages to DMJM's actions, will survive this motion, because **the Court cannot find, at this juncture, that under no circumstances will Plaintiff be able to prove that any of its requested damages with respect to these claims are attributable to DMJM alone** For the foregoing reasons, the Court grants Defendant's motion to limit damages in part and denies it in part. Specifically, the Court finds that Plaintiff may not use the cumulative impact theory of causation or modified total cost method to prove its damages in this case. **Indeed, AMEC will have to show which of its specific damages, proven to a reasonable degree of certainty, are causally related to DMJM's alleged negligence. Further, the Court grants Defendant's motion for summary judgment, dismissing Plaintiff's claim for costs and fees incurred in the State Action."**	(Employer/Engineer) v. Contractor	Failed	**● FC2: Contractor has failed to prove causation and resultant injury** **● FC4: Contractor could not separate its impacts from employer/engineer caused impacts.**

C14	COLONNA'S SHIPYARD, INC., Plaintiff, v. UNITED STATES OF AMERICA, through the DEPARTMENT OF THE NAVY, and its activity, the NORFOLK SHIP SUPPORT ACTIVITY, Defendant.	2015	"Although it is difficult to calculate disruption with certainty, Plaintiff must show that the damages claimed resulted from the cumulative impact of Modifications twenty-six (26) to forty-six (46). Colonna's has not **come forward with evidence sufficient to show that the work performed as a result of the applicable modifications actually had the disruptive impact claimed. The bulk of evidence presented focused on whether Colonna's had the contractual right to seek cumulative impact but neglected to show that Colonna's was actually entitled to it.** The Court will not make such assumptions. **Although disruption need not and often cannot be proven with mathematical certainty, Colonna's has not presented evidence sufficient to show how the Contract work was disrupted as a result of the fixed-price modifications in accordance with the amount claimed. This claim fails.** Youngdale, 27 Fed. Cl. at 541 (quoting Servidone Const. Corp, 931 F.2d at 862), and it "is highly disfavored by the courts, because it blandly assumes—that every penney [sic] of the plaintiffs costs are prima facie reasonable." Id. The Court has already determined that "every penny" of Plaintiff's costs were not reasonable, and as such, it cannot compute damages based on total cost incurred. Accordingly, use of the modified total cost method of calculating damages is not appropriate in this matter **Further, Plaintiff has not satisfactorily established that the work performed was materially different from that specified in the Contract. Despite the difficulties encountered, a contract** to repair a ship remained a contract to repair a ship, and the modifications indicate that these changes were clearly redressable under the Contract. Had the changes been so profound that they were not redressable, it is unlikely that the parties would have been able to negotiate forty-six (46) bilateral contract modifications	(Employer) v. Contractor	Failed	**● FC2: Contractor has failed to prove causation and resultant injury** **● FC3: Contractor could not prove that a fundamental change in the character of the work had taken place and thus no costs had been experienced whose likelihood had not been foreseeable.**

C15	Coley Properties Corp. v. United States	1979	**“The delay that the changes the government ordered in the postal portion caused Coley in completing the tower portion, with its concomitant additional expenses to Coley in completing the tower, is an item of additional impact cost for which the government is liable, even though Coley still was able to complete the tower portion within 3 years after the postal portion was turned over to the Post Office.”**	Employer v. (Contractor)	Succeeded	**● SC1: Contractor could prove that it has experienced large number of changes that impacted productivity/unchanged works** **● SC2: Contractor was unable at the time of pricing of each change or event or directive to foresee the ripple-type effect of the multiplicity of change and events;** **● SC3: Contractor was able to prove causation and resultant injury**
C16	Appeal of David J. Tierney, Jr., Inc. GSBCA No. 7107, May 3, 1988	1988	“Principally, we find on balance that the Government’s numerous changes to the contract impeded appellant’s completion of the job, substantially increasing its costs and eradicating its anticipated profit. Although we are not able to pinpoint, day by day, the effect of each change on each item of work**, we do find that some of those changes had a cumulative impact on job progress as a whole, for which appellant is entitled to compensation**.” **... Neither statement of boilerplate clearly indicates an intent by the parties to settle appellant's potential claims for cumulative impact costs, and therefore the change orders will not now bar those claims.**	Employer v. (Contractor)	Succeeded	**● SC1: Contractor could prove that it has experienced large number of changes that impacted productivity.** **● SC4: The Contractor did not knowingly waive the right to assert cumulative impact claims when negotiating changes**

C17	Bell BCI Co. v. United States 2008	2008	“The first issue on appeal is whether the release language in paragraph 8 of Mod 93, repeated in later modifications, covers Bell's cumulative impact claims. Paragraph 8 says that the modification "provides full compensation for the changed work" and that Bell "hereby releases the Government from any and all liability under this Contract for further equitable adjustment attributable to the Modification." . . .In finding for Bell, the Court of Federal Claims drew a distinction between a "delay" claim and a "disruption" or "cumulative impact" claim. The court stated that "although the two claim types often arise together in the same project, a `delay' claim captures the time and cost of not being able to work, while a `disruption' claim captures the cost of working less efficiently than planned. . . . The Court of Federal Claims, however, found that Bell and the government n**ever had any meeting of the minds, and that the government did not provide consideration for Bell's release . . .”** **“Again, we defer to the trial court's finding that "evidence of excusable delay from changed work" was "so overwhelming that a reasonable person could not reach a contrary result."** Bell BCI, 81 Fed.Cl. at 640. We also defer to the court's determination that the government's expert, who concluded that NIH caused just thirty-two days of delay on the project, was "simply . . . not credible." “Through 1999, Bell had completed a significant portion of the base Contract work … and incurred a nonproductive work rate of eight percent on the project … Mr. Brannon attributed one-half of the nonproductive hours to Bell for this period, and set Bell’s reasonable productivity level at 104 percent of the originally planned productivity … Mr. Brannon compared actual hours incurred on the project against 104 percent of the originally planned hours to calculate unearned hours attributable to the NIH changes. Mr. Brannon found that approximately 25 percent of Bell’s total hours expended on the project **were attributable to labor productivity loss caused by the NIH changes.”**	Employer v. (Contractor)	Succeeded	**● SC1: Contractor could prove that it has experienced large number of changes that impacted productivity.** **● SC2: Contractor was unable at the time of pricing of each change or event or directive to foresee the ripple-type effect of the multiplicity of change and events.** **● SC5: The Contract release was not considered enforceable knowing that the parties did not have meetings of the minds.**

C18	Costello Construction Co. of Maryland, Inc. v. City of Charlottesville, 97 F. Supp. 3d 819 (2015)	2015	" . . . Contractual claims, whether for money or other relief, shall be submitted in-writing no later than 60 days after final payment. However, written notice of the contractor's intention to file a claim shall be given at the time of the occurrence or the beginning of the work upon which the claim is based. . . . The City argues that Costello's claims for cumulative impact damages, set forth in Counts I, II, and III of the complaint, essentially seek to recover for "ripple effects" related, at least in part, to those previously-submitted claims. The City contends, therefore, that the VPPA's exhaustion requirement mandates that Costello submit its cumulative impact claims to the VAB. The court disagrees. Costello asserts, however, that its claims seek damages "for cumulative impacts and disruption resulting from numerous defective specifications, changes to the work, and the City's failure to provide timely direction," whereas the claims previously submitted to the VAB "involved specific proposed change orders and the associated direct damages and delays."2 PL's Br. in *825Opp. at 10, Docket No. 8; see Bell BCI Co. v. United States, 72 Fed.Cl. 164, 168 (2006) (noting a distinction between delay claims and disruption or cumulative impact claims)." … Although the City's argument may have merit, the court cannot say, based on the face of Costello's complaint alone, that its current claims are so inextricably intertwined with those presented to the VAB that they cannot be pursued in this court. See Schlosser, 975 F.2d at 1079. The court therefore declines to dismiss Counts I, II, and III at this stage in the proceedings	(Contractor) v. Employer	Succeeded	● SC1: Contractor could prove that it has experienced large number of changes that impacted productivity.

4.3.2 Failure Criteria:

Table 14: Failure Criteria of Cumulative Impact Claims (As Deduced from Examined Cases)

	FC1	**FC2**	**FC3**	**FC4**	**FC5**	**FC6**	**FC7**	**FC8**	
Case Code	**Contractor could not resort to the cardinal change doctrine knowing that it had entered into a new agreement to perform the works with an agreed price**	**Contractor has failed to prove causation and resultant injury**	**Contractor could not prove that a fundamental change in the character of the work had taken place and thus no costs had been experienced whose likelihood had not been foreseeable.**	**Contractor could not separate its impacts from employer caused impacts.**	**Contract contained release language and/or barred the Contractor from collecting cumulative impact under the doctrine of accord and satisfaction**	**Contractor failed to submit a notice to reserve its right to collect cumulative impact at a later date.**	**Contractor failed to prove that impacts were unforeseeable**	**Contractor failed to prove how the changes impacted its productivity (performanc e time and efficiency).**	**Frequency of Failure Criteria per Case**
C1						√			1
C2	√				√				2
C3		√		√					2
C4			√	√					2
C5			√						1
C6					√				1
C7						√	√		2
C8		√						√	2
C9		√							1
C10		√			√	√			3
C11		√	√						2
C12					√				1
C13		√		√					2
C14		√	√						2
Total	1	7	4	3	4	3	1	1	24

4.3.3 Success Criteria:

Table 15: Success Criteria of Cumulative Impact Claims (As Deduced from Examined Cases)

Case Code	SC1 Contractor could prove that it has experienced large number of changes that impacted productivity/unchanged works	SC2 Contractor was unable at the time of pricing of each change or event or directive to foresee the ripple-type effect of the multiplicity of change and events;	SC3 Contractor was able to prove causation and resultant injury	SC4 The Contractor did not knowingly waive the right to assert cumulative impact claims when negotiating changes	SC5 The Contract release was not considered enforceable knowing that the parties did not have meetings of the minds.	Frequency of Success Criteria per Case
C15	√	√	√			3
C16	√			√		2
C17	√	√			√	3
C18	√					1
Total	4	2	1	1	1	9

4.4 Elements of a Cumulative Impact Claim

There are three main elements for proving a cumulative impact claim: (1) liability, (2) causation, and (3) resultant injury (Hanna and Swanson, 2007; Backus, 2010; Centex Bateson Constr. Co. v. West, 250 F.3d 761 (2000)).

4.4.1 Liability:

Liability is considered to be the easiest to prove knowing that it can be established by showing that the contractor has encountered a substantial amount of employer changes and disruptions (Keating, 2000). In Centex Bateson Constr. Co. v. West, 250 F.3d 761 (2000)), liability was not an issue of dispute considering the fact that all issued changes were admittedly issued by the employer.

4.4.2 Causation:

Proving causation and resultant injury is considered to lie at the core of proving any cumulative impact claim. Cumulative impacts are often denied by courts because there were insufficient number of changes, disruption, and inefficiencies, and or many contractor-caused concurrent delays (Bechtel Nat'l. Inc., NASA BCA No. 1186-7, 90-1).

This is evident by the fact that a key failure criteria of the above studied case law was the failure of the contractor to establish causation and prove resultant injury. Other cases (similar to C4 & C5) the contractor simply needed to prove that a cardinal change has been established to satisfy the first two elements of proof (i.e. liability and causation; in this case, the only remaining element of proof would be resultant injury) (Backus, 2003). However, as evident in the studied cases, showing that a large number of changes has been encountered by the contractor resulting in cost overrun, is not enough to establish causation. The contractor must prove causal nexus and establish a link between the substantial amount of changes and the cost overrun (Centex Bateson Constr. Co. v. West, 250 F.3d 761 (2000)).

Another way to prove causation is to demonstrate that there are no other reasons for loss of productivity other than those directly attributed to the employer. In other words, the contractor shall be able to prove that all the ensuing cost overruns and disruptions are for reasons solely attributed to the employer**.** This is risky, because in this case the contractor will be opting for a "total cost approach" whereby the contractor shall be able to show that (1) it is impractical to prove actual losses directly (linking losses to direct events), (2) the reasonableness of its bid, (3) and the lack of responsibility and liability for all cost overrun (Fitzgerald, 2002). If the contractor adopted a total cost approach, the employer can simply defeat the former's claim by simply showing that the incurred additional costs are also associated with causes attributed to the contractor and/or by the contractor's inefficiencies which are not related to any action of the employer/engineer. Accordingly, one option the contractor has, is to prove that the incurred changes have resulted in changes to the working conditions which accordingly resulted in loss of productivity justifying the contractor's entitlement to a cumulative impact claim (Fitzgerald, 2002; Backus 2003).

In attempting to prove the change in working conditions, contractors shall make sure to closely maintain sufficient contemporary records. For instance, in David J. Tierney, Inc., the court allowed the contractor to recover under cumulative impact and stated: "Principally, we find on balance that the Government's numerous changes to the contract impeded appellant's completion of the job, substantially increasing its costs and eradicating its anticipated profit. Although we are not able to pinpoint, day by day, the effect of each change on each item of work, we do find that some of those changes had a cumulative impact on job progress as a whole, for which the appellant is entitled to compensation.” In this case the resultant injury was determined using the jury verdict method based upon a perceived balance of liability between the contractor and the government. The court was unable to precisely pinpoint when the compensable impact occurred.

4.4.3 Resultant Injury:

Generally, in most cases involving cumulative impact claims, the resultant injury is determined using the total cost approach, modified total cost approach, jury verdict method, or the measured mile approach. Other quantification methods were discussed in Section 2.3 of this research.

According to Hannah and Swanson (2007), an additional key element was considered vital to proving a cumulative impact claim; the latter being “foreseeability and accord and satisfaction”. Accordingly, the five elements that were identified by Hannah and Swanson to provide sufficient burden of proof to establish the validity of any cumulative impact claim were:

- The contractor shall show that it has experienced a significant number of changes or disruptive events (liability).
- The contractor shall prove that the changes and events had an impact on its performance in terms of productivity and efficiency (causation and resultant injury).

- The contractor shall demonstrate that the impact is a result of the synergy of the number of change orders and changes in the scope of the works (causation).
- The contractor shall prove that it was unable at the time of pricing each change order or event to foresee the cumulative effect (ripple effect) of the numerous change orders and events (foreseeability and accord and satisfaction).
- The contractor shall not knowingly waive the right to assert cumulative impact claims when negotiating individual change orders (foreseeability and accord and satisfaction).

4.4.4 Foreseeability and accord and satisfaction:

In summary, any impact deemed foreseeable by the contractor while negotiating change orders, shall be included in the contractor's assessment and therefore not recoverable under a cumulative impact claim (Hannah and Swanson, 2007; Fitzgerald, 2002; (Hannah and Swanson, 2007; Fitzgerald, 2002; Pittman Construction Co. v. United States (1983); Appeal of Freeman-Darling, Inc. GSBCA No. 7112 (1989); J.A. Jones Construction Company v. Lehrer McGovern Bovis Inc and National Fire Insurance Company Of Hartford (2004); Colonna's Shipyard, Inc., , V. United States of America (2015)).

In Pittman Construction Co. v. United States (1983), the board stated that: "The problem [of proving cumulative impact claims] is almost a tort problem—foreseeability. When pricing the changes individually, the contractor may not have taken into account the synergistic effect of all the changes collectively, and it may therefore recover only those impact costs relatively easy to foresee, i.e. those that are customarily referred to as ‘direct’ impact costs. Failing to foresee the so-called cumulative impact costs, the contractor fails to claim them, and thereby obtains a compensation that is actually less than the full compensation for the changes being negotiated.”

Moreover, the case may be that change orders may contain a stipulation that waives the contractor’s rights to subsequently claim for a cumulative impact. In addition to the aforementioned, the conditions of contract may contain certain provisions that provide for contingency options that waives the contractor’s rights to any cumulative impact and/or contingencies occurring afterwards after agreeing to the individual impact of a certain change order (Jones, 2001).

A vital issue, that should be considered by the contractor, and that is the most common defense mechanism used by employers against cumulative impact claims, pertains to the contractor knowingly releasing or waiving its right to collect cumulative impacts. This is usually enforced by the contractor’s signature on change orders that contain a release language similar to the following: “The contract period of performance remains the same. It is further understood and agreed that this adjustment constitutes compensation in full on behalf of the contractor and his subcontractors and suppliers for all costs and markup directly or indirectly, including extended overhead, attributable to the change order, for all delays related thereto, and for performance of the change within the time frame stated.”

Accordingly, if the contractor did not reserve its rights to subsequently recover any potential impact changes, it will be barred from doing so under the doctrine of accord and satisfaction. In Jackson Construction Co., Inc. v. The United States (2004), the court specified the elements to establish accord and satisfaction: “An ‘accord’ is a contract under which both parties agree that one party will render additional or alternative performance in order to settle an existing claim made by the other party, and ‘satisfaction’ is the actual performance of the accord. The party asserting an accord and satisfaction defense must establish four elements: (1) proper subject matter; (2) competent parties; (3) a meeting of the minds; and (4) consideration . . . An executed bilateral modification with a release provision usually constitutes an accord and satisfaction unless that release is either ambiguous or limited in scope.” In the same case the court ruled that “An executed bilateral modification with a release provision usually constitutes an accord and satisfaction unless the release is either ambiguous . . . a contractor may preserve its rights to assert additional claims for the work covered by the modification.” The court added that: “ the Court must focus whether or not the parties’ objective manifestations of intent demonstrate that they reached a meeting of minds with respect to the release of additional claims . . . even if the parties have executed a clear and unambiguous release, this court can void or reform the release on several grounds, including lack of consideration, lack of performance, lack of authority, unilateral or mutual mistake, misrepresentation, duress, or under other circumstances in which the parties’ conduct evinces to allow additional claims.”

4.5 Conclusion and Concluding Remarks:

4.5.1 Interconnections between Failure and Success Criteria

Based on the above, it can be deduced that issue of cumulative impact claims has been a subject of dispute between the parties to the contract. Notwithstanding, it is evident that there is an interconnection between the deduced success and failure criteria. A number of success and failure criteria mirror each other as highlighted here below:

1. FC2 & FC4 v. SC3: It was deduced that for the contractor to be able to submit a successful cumulative impact claim that is accepted by courts, the latter shall be able to prove causation and resultant injury resulting from the synergistic effect of change order (SC3). Based on the reviewed case law, the contractor's failure to prove causation and resultant injury (FC2) was considered to be the most recurring failure criteria. For the contractor to successfully prove causation, it shall be able to prove that all the ensuing cost overruns and disruptions are for reasons solely attributed to the owner (FC4).

2. FC3 & FC7 v. SC2: Any impact considered to have been foreseeable by the contractor while negotiating change orders was considered by courts as not qualifying to be submitted under a cumulative impact claims (FC3 & FC7) unless the contractor was able to prove that it was unable at the time of pricing each change order to foresee the synergistic effect of the substantial number of changes (SC2).

3. FC1 & FC8 v. SC1: The contractor could prove that the cumulative impact of changes has risen to the level of a cardinal change (FC1) (discussed in details under Chapter 5 of this research). Noting that proving that a cardinal change has been established is not considered anymore as a pre-requisite to recover under a cumulative impact claim (as discussed in details under 4.2 "Evolution of Historical Principles" of this research). Moreover, the contractor shall be able to establish a nexus

between the instructed changes and their impact on productivity/unchanged works (FC8; SC1).

4. FC5 v. SC5: One of the most commons defense mechanisms deployed by employers disallowing contractors to recover a cumulative impact claim pertains to the contractors knowingly releasing or waiving its right to collect cumulative impact (FC5) that is usually enforced by the contractors signing a release language that constitutes waiver. This is analyzed by courts based on the doctrine of accord and satisfaction that was discussed under section 4.4.3 here above whereby a release might not be considered enforceable if the parties to the contract did not have meeting of the minds (SC5).

5. FC6 v. SC4: It is evident that if the contractor failed to reserve its rights to subsequently recover any potential impact of changes, it will be barred from doing so under the doctrine of accord and satisfaction (FC6). It is always better for the contractor to submit a timely notice to reserve its right for any impact not readily foreseeable and/or computable by the time of negotiating change orders; however, in some cases courts have allowed the contractor to recover cumulative impact considering that the latter did not knowingly waive its right to assert cumulative impact claims while negotiating individual change orders (SC4).

The below figure further illustrates the above:

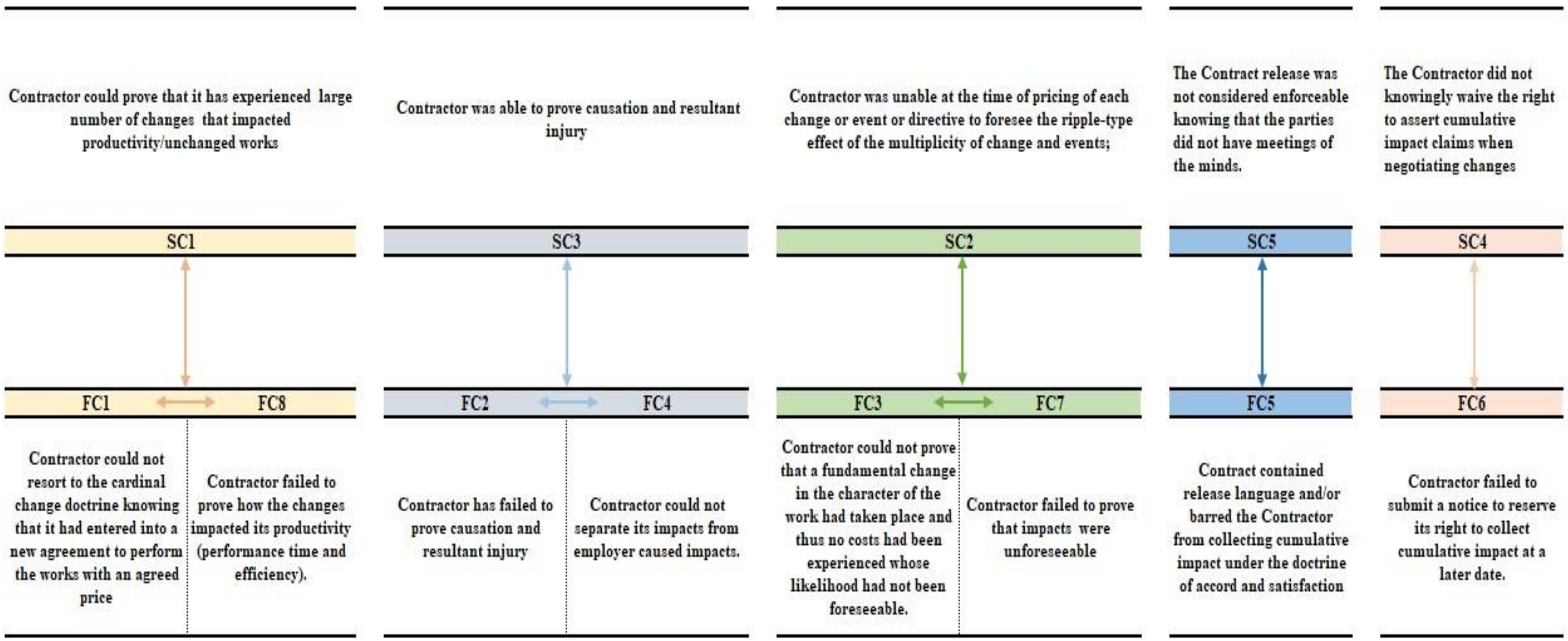

Figure 9: Interconnections between success and failure cirteria pertaining to cumulative impact claims

4.5.2 Key Takeaways:

The key takeaways of this chapter can be summarized as follows:

1. Based on both the literature and the case law analysis, it can be deduced that the vital elements of any successful cumulative impact claim are: (1) liability, (2) causation, and (3) resultant injury, and (4) foreseeability and accord and satisfaction.
2. Cumulative impacts can rise to the level of a cardinal change to the works (further discussed in the following chapter).
3. Courts, till date, do not have a clear and comprehensive criteria on admissibility of cumulative impact claims whereby every case shall be analyzed based on its own facts and proceedings.

CHAPTER 5

CARDINAL CHANGES

5.1 Introduction

Construction contracts contain clauses stipulating how the contractor can recover cost and time impacts resulting from change orders to the scope of works. Such clauses generally specify notice requirements, valuation requirements, along with approval requirements. The latter may also limit the contractor's recovery through setting in the contract a fixed overhead and profit margin that shall be applied and/or by stating that certain impacts cannot be recovered (Silberman, 2004). Moreover, construction contracts typically allow the employer/engineer to unilaterally instruct variations to the scope of work without capping the limit or extent of such changes and without cancelling or abandoning the contract (Stockenberg, 2002).

Notwithstanding the above, in the case of construction projects that suffer a substantial amount of change orders, what happens when the number of scope changes are excessive and might go beyond what either parties have anticipated for upon contracting? In such circumstances, resorting to the contract clauses might sometimes become inadequate because the overall impact of such changes might have totally altered the contractor's scope of work and affected the entire undertaking of the contractor.

In this regard, significant questions arise:

1. What is the criteria that classifies a change as a cardinal change and what are the legal contractual consequences if the contractor claimed that a cardinal change has been induced? Could it lead to contract abandonment and annulment?

2. Could a cardinal change be a result of a single change or could it be a result of a series of changes that amount to a significant deviation from the contemplated scope of the project?

3. If the contractor put forward a cardinal change claim, what are the success and failure criteria of such a claim?

The aim of this chapter is to try to answer the above questions after examining both literature and case law with regards to the same.

5.2 Definitions

After a thorough examination of the literature and case law, several definitions of a cardinal change were obtained and summarized vide Table 16.

Table 16: Definition of Cardinal Change

No.	Definition(s)	References
1	● “A "cardinal change" may occur whenever there is a substantial amount of work required outside the scope of the original contract.” ● “A "cardinal change" does not necessarily refer to a single change, but can be a whole series of changes that amount to a significant deviation from the project. On the other hand, the presence of numerous and frequent changes does not automatically mean there is a "cardinal change”.”	Cox, R., 1997. Managing Change Orders and Claims. Journal of Management in Engineering, 13(1), pp.24-29.
2	“A cardinal change can occur in a couple situations: ● the employer mandates a proposal that a contractor perform a change that is outside of the scope of the contract and ● the employer directs multiple or drastic change orders that cause the work to become materially different from what was expected when the parties entered into the contract.”	Hanna, A. S., and Swanson, J. (2007). “Risk Allocation by Law—Cumulative Impact of Change Orders.” Journal of Professional Issues in Engineering Education and Practice, 133(1), 60–66.

3	● “Federal law uses the term ‘‘cardinal change.’’ A cardinal change ‘‘occurs when the government effects an alteration in the work so drastic that it effectively requires the contractor to perform duties materially different from those originally bargained for.’’ (PCL, 2000, 2004; AT & T Communications, 1993). ● “If the government attempts to impose a ‘‘drastic modification’’ of the contract onto the contractor, the government has affected a ‘‘cardinal change”.”	White, N., 2006. Destruction of the Contract through Material Changes. International Journal of Construction Education and Research, 2(1), pp.43-51.
4	● “A "cardinal change", "one that fundamentally alters the contractual undertaking of the contractor, [and] is not comprehended under the normal changes clause," occurs when an employer's individual change alters the contractor's terms of performance to such an extent that the scope of performance is beyond the original contemplated scope of work of the parties.”	Backus, L. E. (2010). “The Cumulative Impact Claim: Where Do We Stand In 2010” Defense Counsel Journal, 206.
5	● “A cardinal change is a direction that goes beyond the power granted by a normal change clause. Contractors are not obligated to perform a change that goes beyond the scope of the work. (Sweet 1994).”	Lee, M.-J. (2002). Artificial Intelligence Approach To Classify And Quantify Cumulative Impact Of Change Orders On Labor Productivity.
6	“A cardinal change occurs when the government effects an alteration in the work so drastic that it effectively requires the contractor to perform duties different from those originally bargained for. By definition, then, a cardinal change is so profound that it is not redressable under the contract, and thus renders the government in breach.”	Atlantic Dry Dock Corp. v. United States, 773 F. Supp. 335
7	“A cardinal change is a breach that occurs when the employer (usually the government) or the general contractor effects an alteration in the work so drastic that it effectively requires the contractor to perform duties materially different from those originally bargained for.”	Stockenberg, R.A (2002). “Cardinal Change has major implications”. Building Design and Construction, 43(1), pp.19.

According to the table above, and by definition, it can be deduced that a cardinal change is any change that:

1. Requires a substantial amount of work outside the scope of the contract.
2. May arise from either a single change or a series of changes.

3. Cause the work to become materially different from what was bargained for under the contract.
4. Fundamentally alters the contractual undertaking of the contractor.
5. Is a direction that goes beyond the power of the changes clause.

5.3 Cardinal Changes: Legal Perspective

5.3.1 Cardinal Change Doctrine

The cardinal change doctrine was developed by courts to avoid any contractual limitation that may hinder the contractor to recover damages in situations where the contractor experiences a cardinal change (Haidar, 2011). The cardinal change doctrine "is a creature of the body of law which has arisen in the context of disputes over government contracts" (Atlantic Dry Dock Corp. v. Unites States. 773 F. Supp. 335). Accordingly, the cardinal change doctrine was developed by courts to provide a breach remedy for contractors who are directed to perform works which are not within the contemplated scope of the contract, and which are not redressable under the contract (Edward R. Marden Corp. v. United States, 442 F.2d 364, 369 (Ct.Cl.1971); J.A. Jones Construction Co. v. Lehrer McGovern Bovis (2004)). In public contracts, the limits under the cardinal change doctrine to the nature and magnitude of changes the government can order under the contract "prevents government agencies from circumventing the competitive procurement process by adopting drastic modifications beyond the original scope of a contract" *(*Cray Research, Inc. v. Department of Navy, 556 F. Supp. 201, 203 (D.D.C 1982). Notwithstanding, the cardinal change doctrine does not only involve government contract, courts have also applied the same to private contracts whereby the contractor had either utilized the cardinal change doctrine or the abandonment principle to recover its losses (Stockenberg, 2002). “Although the cardinal-change doctrine was created as a check on the government's ability to circumvent the competitive-bidding process by ordering drastic changes beyond those contemplated in the contract, and has been predominantly discussed in disputes based on government contracts, its underlying premise - that compensation for costs resulting from an abuse of authority under the changes clause should not be limited by the terms of that clause - applies to private contracts that include changes clauses.” (J.A. Jones Construction Co. v. Lehrer McGovern Bovis (2004)**.** Moreover, according to Sweet (1989), the doctrine of cardinal change was also "developed not primarily to deal with an abuse of the changes clause, but because of jurisdictional aspects of federal procurement.”

Prior to 1978, a dispute between an employer and a contractor would have to initially go before an agency board of contract appeals if it rose under the contract. To bypass the Board of Claims (U.S Claim Court), the contractor had to show that there has been a breach of contract. To prove that a breach has occurred, the contractor had to show that it had experienced a substantial number of changes or other wrongful conduct that can be classified as a breach. (L.K. Comstock & Co. v. Becon Construction Co. (1993).

Knowing that the power of the employer to order changes, be it a federal or a private agency , is subject to abuse (Sweet , 1989), standard government contracts’ changes clause permits the government to unilaterally order changes "within the general scope of this contract"' (*Air-A-Plane Corp. v. United States,* 408 F.2d 1030, 1032 (Ct.Cl.1969). Notwithstanding, and considering the fact that changes clauses are found in most private construction contracts as well, (example: AIA document A201, general conditions of contract, Art. 7, including the agreement of the parties in the instant case; FIDIC 1999 standard form of contract clause 13 etc…), claims court and other federal courts have consistently ruled that:

“A changes provision does not authorize a "cardinal" change a drastic modification beyond the scope of the contract. Rather, a fundamental alteration of this type is a contract breach, entitling the contractor to breach damages” (*Air-A-Plane Corp. v. United States*, 408 F.2d 1030, 1032 (Ct.Cl.1969).

The theory of cardinal change, thus, allows a contractor to bring in an action for material breach of contract by alleging that the changes ordered exceed the reasonable expectations of the parties (L.K. Comstock & Co. v. Becon Construction Co. (1993)).

There is no specific point, however, at which changes to the contract are considered to be beyond the scope of works and inconsistent with the changes clause whereby the court noted that “there is no exact formula for determining the point at which a single change or a series of changes must be considered to be beyond the scope of the contract and necessarily in breach of it. Each case must be analyzed on its own facts and in light of its own circumstances, giving just consideration to the magnitude and quality of the changes ordered and their cumulative effect on the project as a whole” (Wunderlich Contracting Co. v. United States, 351 F.2d 956 (Ct.Cl.1965)).

Thus, it can be deduced that the cardinal change doctrine has not been universally accepted (Claude DuBois Excavation v. Town of Kittery, 634 A.2d 1299, 1301–02 (Me. 1993)); It is fact dependent whereby each case must be analyzed based on its special circumstances (Air-A-Plane Corp v. United States, 187 Ct. Cl. 269, 408 F.2d 1030, 1033

(Ct. Cl. 1969) ; L.K. Comstock & Co. v. Becon Constr. Co., 932 F. Supp. 906, 909 (E.D. Ky. 1992)) and "no rule of thumb exists to measure what constitutes a cardinal change" (Miller Elevator Co. v. United States, 30 Fed. Cl. 662, 677 (1994)).

In summary, a number of courts have recognized and applied the cardinal change doctrine (knowing that it may not always bear the name of "cardinal change") allowing the contractor to recover damages (in some form) for breach. In some cases the contractor may opt to use the principle of abandonment. "Both abandonment and cardinal change may properly be utilized to establish a basis for recovery outside the original contract in cases where the contractual obligations of a construction contractor vary materially from the original expectations of the parties regarding the scope and manner of work"; Regardless the party performing the work had been entitled to seek a remedy outside the contract upon a quantum meruit (L.K. Comstock & Co. v. Becon Construction Co. (1993)); C. Norman Peterson Co. v. Container Corp. of America, 172 Cal. App. 3d 628, 218 Cal. Rptr. 592 (1985).

5.3.2 Case Law: Success and Failure Criteria

For the purpose of identifying the success and failure criteria pertaining to cases where contractors have put forward cardinal change claims resulting from the substantial amount of change orders, a case law review was conducted and cases where analyzed to deduce the major set of said criteria along with the frequency of each in the analyzed cases. Cases spanning from 1937 to 2021 were identified and analyzed as delineated vide Figure 10 and Table 17.

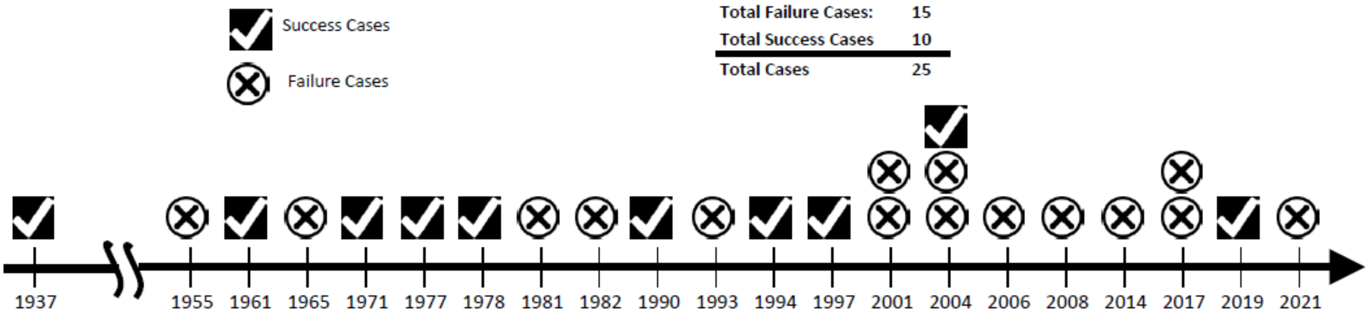

Figure 10: Cardinal Change - Case Law Timeline

Table 17: Cardinal Changes Case Law Table

Case Name	Year	Court Ruling	Dispute between: [“( )” Identifies the party for which the ruling was in favor of]	Status	Success/Failure Criteria

General Contracting & Construction Co. v. United States	1937	"On January 13, 1931, the contracting officer issued a formal change order under Article 3 of the contract eliminating from the contract Nurses' Quarters Building No. 17, and by reason of such change decreased the contract price by $99,520.00. . ..Upon the elimination of Building No. 17 plaintiff took up with its subcontractors negotiations for contracts covering the materials required for the work, omitting Building No. 17, and found that its subcontractors in the main would not enter into the contracts for the materials to be furnished by them at the unit prices quoted in their proposals. We find, upon a careful review of the evidence heard by the Commissioner of the court, that plaintiff's loss as fixed by him is amply supported by the proof, and have made a finding of fact that because of the elimination of Building No. 17 from the contract plaintiff sustained loss and damage to the extent of $20,773.00 The defendant does not challenge the finding that plaintiff has sustained loss and damage to the extent of $20,773.00 because of the elimination of Building No. 17, but rests its case entirely on the assumption that the elimination of Building No. 17 was a change in the drawings and specifications of the contract within the meaning of Article 3 of the contract, and that the decision of the Director of the Veterans' Bureau that a deduction of $99,520.00 from the contract price, the amount fixed by the contracting officer in the change order, was an equitable adjustment of the matter, is final and conclusive under Article 15 of the contract. Article 3 of the contract is a standard form used by the Government in all construction contracts. Its purpose is to enable the contracting officer to make any change in drawings and specifications he may find necessary or desirable as work under the contract progresses. It has reference, we think, entirely to structural changes like the substitution of one kind of material for another, changes in architectural design, the addition to or subtraction from work required by the specifications, etc. **Certainly the authority vested in the contracting officer by this article of the contract to make "changes in the drawings and (or) specifications of this contract and within the general scope thereof" did not vest him with authority to eliminate entirely from the contract Building No. 17. If he could eliminate one building from the contract under the guise of making changes in the drawings and specifications he could likewise eliminate two or any number of buildings and thus entirely change the contract. The elimination of Building No. 17 amounted to a cardinal change or alteration of the contract itself, a thing that could only be consummated with the consent of both parties to the contract. The elimination of Building No. 17 from the work to be performed under the contract without the consent of plaintiff was a plain breach of the contract by the defendant.** **The defendant having breached the contract plaintiff is entitled to recover its damages arising therefrom, and judgment is therefore awarded plaintiff in the sum of $20,773.00.**"	**(Contractor)** v. Employer	Succeeded	**SC1: Introduced changes are beyond what the parties have reasonably anticipated under the Contract and/or beyond the general scope thereof**

F. H. McGraw & Co. v. United States	1955	"On December 2, 1947, Change Order "XX" was issued increasing the contract price by $403,245.41, which represented the contracting officer's equitable adjustment for the changes made by the new drawings and specifications. This did not include any amount for damages for delay because the contracting officer and head of the department stated that they had no authority to award damages. The plaintiff contends that the changes were beyond the scope of the contract and that the VA's stoppage of the work, together with its failure to promptly decide on the changes to be made, was a breach of its contract. The defendant contends that since the VA reserved the right under Article 3 of the contract to make changes in the drawings and specifications within the general scope thereof at any time, and also reserved the right under section 3(h) of the specifications to suspend any portion of the contract work, the partial stop order and delay •incident thereto was not a breach of the contract. **The changes made under change order "XX" were within the general scope of the contract. Although the changes were extensive, they were not so extensive as to be a cardinal change. That the defendant had the right to make changes is clear. Article 3 of the contract.** The plaintiff claims the difference between the original contract price for all the work, as increased by change orders, and its direct cost of completing the job. Plaintiff's costs were $3, 987, 712.50, and the contract price as increased by change orders was $3,575,123.40, a difference of $412,589. It also claims $40,846.61 as certain home office and field overhead. This is a total of $453,435.71. Plaintiff states that if the court finds against it on the wage claim, which we have, that $66,659.37 should be deducted from the $453,435.71. **This method of proving damage is by no means satisfactory, because, among other things, it assumes plaintiff's costs were reasonable .and that plaintiff was not responsible for any increases in cost, and because it assumes plaintiff's bid was accurately computed, which is not always the case, by any means."**	Contractor v. **(Employer)**	Failed	**FC1: Changes were not substantial as to amount to a cardinal change to the contemplated scope of works** **FC2:Could not separate its impacts from the other party's related impacts** **FC3: Failure to prove causation and/or resultant injury.**
Saddler v. United States	1961	**"We are of the opinion that the nature of this particular contract was so changed by the added work, albeit the same kind of work described in the original specifications, as to amount to a cardinal alteration falling outside of the scope of the contract. Some of the reasons which compel us to decide as we do about the character of the change are also pertinent to the problem of damages."**	**(Contractor)** v. Employer	Succeeded	**SC1: Introduced changes are beyond what the parties have reasonably anticipated under the Contract and/or beyond the general scope thereof**

Wunderlich Contracting Company, a Nebraska Corporation, Curlett Construction Company, a California Corporation, and Chas. H. Thompkins Company,1 a District of Columbia Corporation v. the United States	1965	“Upon a review of the evidence as a whole, we conclude that such changes as were ordered by the contracting officer here were not cardinal in nature. Although extensive in number, they were entirely within the scope of defendant's discretion to make under the Changes article of the contract. Plaintiffs have been compensated by price adjustments for the verified costs of carrying out these alterations, and have not shown by a preponderance of the evidence that they are entitled to any additional sum.”	Contractor v. **(Employer)**	Failed	**FC1: Changes were not substantial as to amount to a cardinal change to the contemplated scope of works**
Edward R. Marden Corp. v. United States	1971	“Further, plaintiff alleges that the whole affair resulted in increased costs of $3,700,000. It is clear that the claim alleged in Count I is not one encompassed by the Changes clause. **The alleged change involved major reconstruction and, according to plaintiff, resulted in increased costs of almost double the contract price.** By any standard the events alleged would have to be deemed to have materially altered the nature of the contractor's undertaking. If plaintiff's allegations are true, then it performed work which was not "essentially the same work as the parties bargained for when the contract was awarded." Aragona Constr. Co. v. United States, 165 Ct. Cl. 382, 391 (1964). **Our decision on this point is based on the sheer magnitude of reconstruction work caused by the alleged defective specifications.** Admittedly this case differs from the usual cardinal change cases in at least one important respect. In the present case the reconstructed hangar was, presumably, the identical hangar called for in the original specifications. In other words, in directing reconstruction of the hangar, the Government did not alter the design or other physical characteristics of the structure. We do not view this as a crucial difference, however. **Where a cardinal change is concerned, it is the entire undertaking of the contractor, rather than the product, to which we look**. **Since we have found that plaintiff's claim, as expressed in Count I, is not encompassed by the Changes clause and we know of no other contract adjustment provision under which Count I would be redressable, we must necessarily conclude that the claim is not redressable under the contract**. The board, therefore, was without jurisdiction to consider the claim. Even though the board evidently was of the opinion that the claim was properly before it, its findings of fact on that claim were gratuitous and such findings do not preclude or limit a trial de novo on the merits of Count II in this court. See Air-A-Plane Corp. v. United States, supra note 3; Morrison-Knudsen Co. v. United States, 345 F.2d 833, 838, 170 Ct. Cl. 757, 764 (1965). Plaintiff has not moved for a de novo trial on Count I. Needless to say, however, in disposing of plaintiff's motion on Count II we have, in effect, held that a de novo trial on Count I would be proper because it alleges a cardinal change. In view of the circumstances we deem it appropriate to consider the two counts as merged into one count for breach of contract.”	**(Contractor)** v. Employer	Succeeded	**SC1: Introduced changes are beyond what the parties have reasonably anticipated under the Contract and/or beyond the general scope thereof** **SC2: Changes affected the entire undertaking of the contractor and/or what the parties have bargained for under the Contract.**

Westinghouse Electric Corp. v. Garrett Corp., 437 F. Supp. 1301 (D.Md.1977),	1977	"It is this court's opinion that under the facts and the applicable law Westinghouse's failure to furnish SCD's until July 26, 1971 was a breach of contract. Moreover, this result obtains under any of the above approaches. The court is primarily of the opinion that Westinghouse's failure to furnish the SCD's was not a change at all, but was an outright departure from the terms of its contractual undertaking and hence a breach in the first instance. But many of the reasons supporting this conclusion equally support the conclusion that even if, as Westinghouse contends**, it supplied all the necessary information through alternative sources, and such action amounted to a constructive change,[46] that change was cardinal.** . . . The court also believes that this substitution would not be a change in or to drawings or designs because in order for there to be a change in something it obviously must pre-exist the change. **Here the drawings for which alternate information sources were substituted never existed. Finally, the substitution was not in or to instructions for work as this court understands that term. Even if this substitution were a change in instructions for work, or in one of the other express designations, there would be a breach of contract because such a change can only be characterized as cardinal. While it may be true, as Westinghouse argues, that source control drawings are principally just a format, they are a format of considerable significance**... **The failure of Westinghouse to deliver final source control drawings to Garrett before July 23 materially affected the timely performance of the subcontract by Garrett.** Since time was expressly made of the essence of the contract, the failure of Westinghouse to deliver final source control drawings seasonably or as agreed constituted (a) a material breach of the subcontract, and (b) a failure of a condition precedent to Westinghouse's right to require counter performance by Garrett. Westinghouse having promised certain drawings and Garrett having a right to those drawings and having demanded them, it would be inimical to the integrity of the contractual process to allow Westinghouse to escape its undertaking by hiding behind the rubric of the Changes Clause. **The Changes Clause is not an absolute excuse for the Government or an adopting prime contractor to avoid the consequences of breach. The courts have made this clear over and over in the adoption of the cardinal change rule and in the cases finding outright breach."**	**(Subcontractor)** v. Contractor	**Succeeded**	**SC1: Introduced changes are beyond what the parties have reasonably anticipated under the Contract and/or beyond the general scope thereof** **SC2: Changes affected the entire undertaking of the contractor and/or what the parties have bargained for under the Contract.** **SC3: Employer abused the use of the change order clause.**

ALLIED MATERIALS & EQUIPMENT CO., INC. v. THE UNITED STATES	1978	"In particular, we instructed the trial judge to determine whether defendant's sale of the production equipment had effected a cardinal change in the contract, within the meaning of such precedents . . . If the trial judge found that there was a cardinal change, thus providing this court with jurisdiction, he was then to determine whether the government was dealing in bad faith prior to and in effecting the termination for convenience . . . Under established case law, a cardinal change is a breach. It occurs when the government effects an alteration in the work so drastic that it effectively requires the contractor to perform duties materially different from those originally bargained for. By definition, then a cardinal change is so profound that it is not redressable under the contract, and thus renders the government in breach.... **We have certainly never intimated, however, that the contractor is limited to a suit for extra costs incurred in performing duties fundamentally outside of the scope of the contract, and we have never held that the applicability of this doctrine is in any way dependent on the nature of damages sought by the contractor. . . Undoubtedly, the cautious contractor might often proceed under the revised contract because of doubt whether he could invoke the cardinal change doctrine. But if he has been prevented from performing, as in any breach case, the award of anticipatory profits is an appropriate remedy."**	**(Contractor)** v. Employer	Succeeded	**SC1: Introduced changes are beyond what the parties have reasonably anticipated under the Contract and/or beyond the general scope thereof** **SC2: Changes affected the entire undertaking of the contractor and/or what the parties have bargained for under the Contract.**
S.J. Groves & Sons Co. v. United States	1981	"Plaintiff argues that it meets this standard, that the disproportionate cost of installing the steel liner, as compared to the contract price for constructing the concrete pipe, cries out "cardinal change! . . Those cases, and others where cardinal changes were established, do not help the present plaintiff. **Here, although plaintiff alleges that it was required to expend $6,000,000 to construct a steel-lined pipeline instead of the contracted-for concrete pipeline costing approximately $2,000,000, plaintiff has not clearly shown that defendant caused this change.** Defendant was willing to accept a rebuilt concrete pipeline or a steel-lined pipeline, and plaintiff offered to produce either, at defendant's option. It was at most an Alphonse-Gaston situation in which defendant did not direct the change until plaintiff had agreed to make it. In these circumstances, combined with the admission of plaintiff that it could not recover any money here that it could not recover before the board, and an insufficient showing that the dispute could be resolved any speedier in court than before the board, we are not persuaded to bypass the board in what otherwise is clearly a case for the board. Since plaintiff's claim in this case was not pending before the contracting officer on the effective date of the Contract Disputes Act of 1978, that act is not applicable to plaintiff's claim; **therefore, direct access to this court under section 10 of the act is not available to plaintiff, and, in the absence of a clear showing of cardinal change,** we cannot exercise our jurisdiction until plaintiff has exhausted its administrative remedies."	Contractor v. **(Employer)**	Failed	**FC3: Failure to prove causation and/or resultant injury.**

Mercury Construction Corp. v. United States	1982	"The decision of the Armed Services Board of Contract Appeals, 80-2 BCA 14,668 (1980), is mostly devoted to a lengthy and exhaustive analysis of the specifications, establishing to its satisfaction that plaintiff could and should have concluded that the fiberglass ducts as originally installed did not conform to the specifications, and plaintiff did not construe them reasonably in asserting that they did. . . Plaintiffs other contention is that the order to replace or fireproof the fiberglass ducts was a "cardinal change." If plaintiff were right about the specifications, and if we were to hold that the ducts first installed were in compliance, plaintiff would be entitled to a constructive change order, with an equitable adjustment to accompany. **This would be a change within the scope of the contract, not a "cardinal change." Instead of being "cardinal," it would have amounted to not much over 1 percent of the contract price. But we have held that defendant's demands were not change orders at all, and, if not change orders, they could not be "cardinal changes."**	Contractor v. **(Employer)**	Failed	**FC3: Failure to prove causation and/or resultant injury.** **FC8: Deviation from the project requirements where attributed to plaintiff; plaintiff failed to abide by its requirements of the Contract**
Universal Contracting & Brick Pointing Co. v. United States	1990	"Count I of Universal's complaint alleges that the removal of asbestos and glue from the exterior walls of the buildings constitutes a cardinal change to the contract which plaintiff did not anticipate. **Universal contends that, although the contract indicates that the buildings had been treated with a Renuit paint system, the contract failed to indicate that Universal might encounter a fibrous material or any material other than paint, during contract performance**. Universal maintains that the fibrous material it encountered on the buildings consisted of glue and asbestos, and that such material differed radically from paint, as to its chemical contents as well as its physical properties. Universal also disputes defendant's contention that the buildings were treated only with Renuit. The government maintains that the contract specifications clearly state that the buildings had been treated with a "Renuit paint system," and a reasonable interpretation of these specifications is that the job entailed removal of Renuit from the exterior brick walls of the buildings. Defendant argues that Universal had the opportunity to inspect the buildings and determine for itself the nature of Renuit and the amount of work involved in its removal. Defendant maintains that plaintiff's interpretation of the contract specifications as requiring the removal of "paint" is unreasonable, because it reads the words "Renuit" and "system" out of the contract. **As the moving party, defendant has failed to carry its initial burden of demonstrating to the court that no genuine issues of material fact exist,** and that it is entitled to summary judgment as a matter of law. See Balboa Ins. Co. v. United States, 775 F.2d 1158, 1165 (Fed.Cir.1985); Udis, supra, 7 Cl.Ct. at 383. Therefore, *defendant's motion for summary judgment on Universal's cardinal changes claim is denied."*	**(Contractor)** v. Employer	Succeeded	**SC1: Introduced changes are beyond what the parties have reasonably anticipated under the Contract and/or beyond the general scope thereof**

L.K. Comstock & Co. v. Becon Construction Co.	1993	"For many of the same reasons that it failed to prove the contract was abandoned, Comstock has failed to demonstrate that it is entitled to restitution on a theory of cardinal change. Although it does not appear, at least insofar as mechanical work is concerned, that Comstock has waived a claim for damages by agreeing to comprehensive contract amendments as in Watt Plumbing and Oberer Construction, supra, Comstock's continued performance of the construction project, its adherence to the contractual change order process, and the novel eleventh-hour reaffirmation of the contract all augur in favor of a remedy under, not apart from, the contract. Cf. Fuller Co., supra, 678 F. Supp. at 510 n. 3. Comstock's action is appropriately one "for breach of the `changes' clause based on [the employer's] alleged failure to make a proper `equitable adjustment' to the contract price." Id. ... **At the time when the plaintiff's work was 90 percent complete, it reaffirmed the agreement, with no reservation of rights, no qualification, no hint that the plaintiff had taken any position as to the contract having been breached by the defendant's ordering of changes outside the scope of the work agreed upon.** ... By any interpretation of the legal significance of Comstock's execution on February 26, 1988, of the Subcontract Agreement, when Comstock signed the agreement it was obligated to assert that the contract was no longer binding or to assert some position in the nature of a reservation of rights to later assert abandonment or breach by excessive changes. **Neither at this time nor during the process resulting in more than 150 additional change orders did Comstock raise the alarm.** Other factors contribute to the conclusion that Comstock should not receive restitution based upon a cardinal change. **Although Comstock did not and could not anticipate all of the changes which ultimately were made on the Project, it was aware at the time of executing the letter of intent that significant extra work was planned, and that it did not have all of the information it needed to specifically price that work** **In addition, Comstock has failed to prove that Becon was responsible for its total extra cost on this Project. Although there is much evidence regarding Becon's failings on the job, there is also evidence that Comstock was at least partially responsible for the inefficiencies and extra costs plaguing the job.** Yet in its proof and arguments Comstock provided no basis upon which the total costs attributable to it may be segregated with reasonable certainty. . . . The plaintiff's burden is to show that the increased costs were brought about by the alleged breach, and on this important issue of causation, the plaintiff's proof was insufficient"	Contractor v. **(Employer)**	Failed	**FC3: Failure to prove causation and/or resultant injury.** **FC9: Plaintiff could not prove that a fundamental change in the character of the work had taken place and thus no costs had been experienced whose likelihood had not been foreseeable.**

Airprep Technology Inc. v. U.S	1994	"The contract in this case gave the government the right to terminate for default in the event that the contractor failed to perform according to the contract terms within the contract period. The defendant has the burden at trial of proving that the contractor defaulted. *Lisbon Contractors, Inc. v. United States,* 828 F.2d 759, 764 (Fed.Cir.1987). In a case such as this, however, application of the burden of proof is a bit problematic. The parties do not dispute that Airprep did not complete contract performance by the formally agreed upon contract date of February 28, 1989; it had yet to perform several items of work. Assuming for argument's sake that this circumstance shifted to Airprep the burden of going forward with evidence at trial to justify nonperformance, **the court concludes for the reasons set forth below that the performance period was indefinitely extended by agreement of the parties, and that the gridlock that occurred thereafter was due to the government's insistence on a cardinal change to the contract.** The changes clause of the contract gave the CO the right to order changes "within the general scope of the contract." Such changes obligate the contractor to perform and then seek compensation for the additional work. If the requirements that the government imposed on Airprep in this case were within the general scope of the contract, then Airprep was obligated to perform, even if the government misinterpreted the contract. A contractor has no right to stop work if the project to be constructed is fundamentally the same as the one it contracted to build. *Aragona Constr. Co. v. United States,* 165 Ct.Cl. 382, 391, 1964 WL 8634 (1964). **A contractor is not, however, obligated to undertake "cardinal changes"— drastic modifications beyond the scope of the contract work**. *Air-A-Plane Corp. v. United States,* 408 F.2d 1030, 187 Ct.Cl. 269, 275 (1969**). The Court of Claims characterized such changes as those that "alter the nature of the thing to be constructed**." *Arago-na Constr. Co.,* 165 Ct.Cl. at 391. The question thus becomes, was METC insisting that Airprep perform beyond the limit of the general scope of the contract at the time of the default termination. **The court concludes that METC's interpretation of section 3.5.3 as requiring proof that the baghouse could tolerate internal pressures in a safety range two to four times an internal pressure of 1.6 psi constituted a cardinal change to the contract**. Mellen testified, without contradiction, that accommodating METC's interpretation would have resulted in an entirely different baghouse. The old one could not have been retrofitted. A baghouse capable of tolerating pressures in the safety range Ayers wanted would have to have been cylindrical, would have used much thicker steel, and could not have been fabricated on site, as was the baghouse Air-prep attempted to furnish. Such a baghouse would have been subject to ASME standards. **Under those circumstances, METC's insistence on its view of the specifications and its rejection of the baghouse without accepting Airprep's assurances that it met performance requirements fundamentally changed the parties' bargain.** Airprep's inability or unwillingness to give METC the assurances that it wanted were not a breach of contract."	**(Contractor)** v. Employer	Succeeded	**SC2: Changes affected the entire undertaking of the contractor and/or what the parties have bargained for under the Contract.** **SC3: Employer abused the use of the change order clause.**

Becho Inc. v. USA	1997	"Plaintiff argued that this cardinal change, together with bad faith exhibited by the Corps in administering the contract, amounted to a material breach of the contract, excusing Becho from further performance. Indeed, while there is no precise calculus for determining whether a cardinal change has occurred, the courts have considered, inter alia, the following factors : (i) whether there is a significant change in the magnitude of work to be performed; (ii) whether the change is designed to procure a totally different item or drastically alter the quality, character, nature or type of work contemplated by the original contract; and (iii) whether the cost of the work ordered greatly exceeds the original contract cost. See Alliant, 178 F.3d at 1276; Paragon Energy Corp. v. United States, 229 Ct. Cl. 524, 527-28(Ct. Cl. 1981); Edward R. Marden Corp., 442 F.2d at 369-70; Thermocor, Inc., 35 Fed. Cl. at 490.4 **As should be evident, these subsidiary questions themselves are intensely factual, almost inevitably obliging this court to receive and weigh evidence – a task that is obviously inappropriate at this juncture of the proceedings**. First, ModificationP00003 was a proposed bilateral change that was never accepted by Becho and thus was legally ineffective. Second, although the parties have debated when Modification P00003 was received by Becho, it clearly was received only in mid-September of 1997, shortly before Becho completed the resorting of pile 2, which work had commenced on August 6, 1997. Finally, both parties admit that the main focus of this litigation is on that portion of Modification P00004 requiring Becho to resort pile 1. **Becho, however, never performed this task. In these circumstances, the court rejects the argument that Becho waived its claim that Modification P00004 was a cardinal change by performing some activities after it received Modification P00003."**	**(Contractor)** v. Employer	Succeeded	**SC4: Defendant failed to prove that the Plaintiff's continued performance constituted waiver; and to prove that the performed works were within the Plaintiff's obligations under the Contract.**
Pellerin Const., Inc. v. Witco Corp	2001	**"Even if the doctrine of cardinal change were applicable, the changes in the scope of the project in this case were not so drastic or profound that they altered the nature of the thing to be constructed. Essentially, the problem Pellerin confronted was delay, not changes in the nature of the project it was asked to perform."**	Contractor v. **(Employer)**	Failed	**FC1: Changes were not substantial as to amount to a cardinal change to the contemplated scope of works**

SCHERER CONSTRUCTION, LLC. v. HEDQUIST CONSTRUCTION, INC.	2001	**"[T]he Court would reject the defense's argument that the cardinal change doctrine be applied in this case as a basis for disregarding the legal obligations established by contract. It would not appear that the cardinal change doctrine has been adopted in the State of Wyoming, nor would such doctrine have application in this case where the claim is not being asserted against the government, and where the subject change order was implemented and directed by the City of Casper, and was contractually beyond the control and authority of Hedquist**. Having rejected the application of the cardinal change doctrine to the situation presented in this case, the breach of contract claim must fail. **The Subcontractor Agreement entered into by the parties reflects that there was an offer, acceptance, and consideration for the contract, and therefore this Court must conclude that there was a meeting of the minds and that an enforceable contract exists**. Further, the Court must give effect to the clear intent of the parties to the Subcontractor Agreement since such intent is expressed therein in clear and unambiguous language. Rissler & McMurry Co. v. Sheridan Area Water Supply Joint Powers Bd. 929 P.2d 1228, 1233 (Wyo.1996). **The clear and unambiguous language of the contract documents quoted herein establish that Scherer agreed to be bound by the terms of both the Main Contract and the Subcontractor Agreement, and thereby agreed to the provisions allowing for change orders on the Project, including the provision that Hedquist could, without invalidating the Subcontract, make changes by altering, adding to, or deducting from the work subject to the agreement. "**	Subcontractor v. **(Contractor)**	Failed	**FC8: Deviation from the project requirements where attributed to plaintiff; plaintiff failed to abide by its requirements of the Contract (The Contract entered into by the parties reflects that there was an offer, acceptance, and consideration for the contract, and therefore there was a meeting of the minds; Changes are part of the defendant's contractual rights under the Contract and fall within the Contract's changes clause)**
Danbert Inc. v. Franklin Cty. Engineer	2004	"Danbert concedes that there was a provision in the contract allowing for "delays." Danbert argues that the trial court's decision "effectively rewards Appellees for an undisputed breach of contract." This was indeed a substantial public project and appellees assert that Hilliard's interference is "an unfortunate common occurrence on a public project." In any case, the record strongly suggests that Danbert was not paid for extra work under the alleged expanded job description. Appellees point out that the contract did contain the aforementioned provision anticipating certain delays. However, the record here demonstrates that the expansion of the contract goes far beyond any reasonable definition of "delay." **This case clearly does not appear to fall within the so-called "cardinal change doctrine." It has been said that each case must be analyzed by its own facts and in light of its own circumstances, given just consideration to the magnitude and quality of the changes ordered and the cumulative effect on the project as a whole.** See Wunderlich Contracting Co. v. United States (1965), 351 F.2d 956, 966. **We agree that Danbert's evidence, if believed, describes very substantial new work here that does not fall within a reasonable definition of delay, nor the "cardinal change doctrine."**	Contractor v. **(Employer)**	Failed	**FC1: Changes were not substantial as to amount to a cardinal change to the contemplated scope of works** **FC3: Failure to prove causation and/or resultant injury.**

Fru-Con/Fluor Daniel Joint Venture v. Corrigan Bros.	2004	"In its third point, Corrigan asserts that the trial court erred in concluding that Corrigan breached the Papermaking contract because the Joint Venture effected a cardinal change and thereby breached the contract, in that (1) after providing Corri-gan with a complete set of isometric drawings for its bidding and building, the Joint Venture changed or revised approximately 2,500 of the 3,600 drawings, (2) the Joint Venture abused its authority under the contractual provisions for ordering changes and making payment for change orders, and (3) the combination of continuous changes to and revisions of isometric drawings and withholding of reasonable contract modifications fundamentally altered Corrigan's work under the contract. [The Joint Venture] may, at any time, by written instructions direct [Corrigan] to make changes, additions, deletions concerning the Subcontract Work, and [Corrigan] shall promptly proceed in compliance with such written instructions. An increase or decrease in the Subcontract Price resulting from such changes shall be agreed upon in writing by the parties hereto. **Such an agreement never happened. As such, we agree with the trial court in finding that Corrigan, not the Joint Venture, breached the Papermaking contract when it walked off the job because the Joint Venture would not accept Corrigan's proposed rates.** Point denied. Corrigan also theorizes that the Joint Venture effected a "cardinal change" and thereby breached the contract. The doctrine of cardinal change breach of contract is rooted in federal contract law. Beaubois v. Marous Brothers Construction, Inc., No, 02-CV-985, 2002 U.S. Dist. Lexis 26625 at (N.D.Ohio Oct. 17, 2002). As a general rule, cardinal change cases have involved suits brought by contractors against the United States Government in the U.S. Court of Claims. Id. The Beaubois Court noted that "no court has limited the doctrine to cases brought against the United States and the recent trend is to analyze the concept of cardinal change even in the context of private construction contracts." Id. Even so, the Court then went on to decline to adopt the cardinal change doctrine in Ohio, noting that neither Mississippi nor Illinois had adopted the doctrine. There are no Missouri cases addressing the cardinal change doctrine. Applying the cardinal change doctrine to the instant case has no support or precedent in Missouri law. **Additionally, the arguments presented by Corrigan in support of its contention that the Joint Venture effected a cardinal change are essentially the same ones presented in support of its arguments that the Joint Venture breached and/or abandoned the contract. Therefore, any discussion would be redundant.** Point denied."	Subcontractor v. **(Contractor)**	Failed	**FC4: Breached the contact when performance was suspended**

J.A. Jones Construction Co. v. Lehrer McGovern Bovis	2004	"Jones asserts that the district court erred by dismissing its "cardinal change/abandonment/quantum meruit" claim on day twelve of the trial. In dismissing the claim for quantum meruit, the district court recognized that Jones had relinquished this claim, and apparently the corresponding contract-abandonment cause of action, when it elected to sue on the contract. … The district court further declined to adopt the cardinal-change doctrine for Nevada courts, and determined that even if the doctrine were available, it would not apply. Jones presented its cardinal-change and abandonment theories as one claim, arguing that contract abandonment and cardinal change were essentially the same and could lead to recovery in quantum meruit. Although Jones attempted to recover all of its claimed additional costs under the terms of the contract, **Jones from the start asserted that the contract schedule and costs no longer pertained to its work.** At that time, LMB directed Jones to continue to work, even though no price for the changed work had been set. Jones asserts that it only attempted to put its "impact costs" into contractual terms after LMB later instructed Jones to do so. **Although the contract's change order provision did not require new prices to be agreed upon before commencing changed work, it is possible that a jury could conclude, based on the facts of this case that both parties impliedly agreed to abandon the terms of the contract. Thus, Jones introduced sufficient evidence to present its theory of contract abandonment to the jury, and therefore, the district court improperly dismissed the contract-abandonment claim** Although LMB relies on PCL Construction Services, Inc. v. United States 39 for the proposition that courts will refuse to find that a cardinal change took place when the structure built is essentially the same structure contracted for**, we agree with the conclusion reached by other courts, that "[a] cardinal change can occur even when there is no change in the final product because 'it is the entire undertaking of the contractor, rather than the product, to which we look.'** In this case, as LMB points out, the overall physical characteristics of Jones's work changed very little. **The real question, however, is whether the entirety of the changes and impacts on Jones's work was so extensive as to force Jones to perform work beyond the confines of the contract**. As set forth above, Jones presented testimony demonstrating material impacts on its contractual scope of work. And, Jones asserts that out of its $7.4 million bid, it expected to capture $1.9 million in overhead and profit, leaving $5.5 million in anticipated costs. The actual costs, according to Jones, totaled over $8.8 million. Additionally, Jones's expert testified that about $4 million, or 62 percent of the Phase I work value, was incurred because of changes. **The evidence required to demonstrate the occurrence of cardinal change is similar to that required by the contract-abandonment theory and, under these circumstances, it appears to us that Jones could also be entitled to relief on its claim under a theory of cardinal change."**	**(Contractor)** v. Employer	Succeeded	**SC2: Changes affected the entire undertaking of the contractor and/or what the parties have bargained for under the Contract.**

Centex Construction v. ACSTAR Insurance	2006	"Defendants argue that the change orders issued by Centex constituted cardinal changes in terms of both the magnitude and the quality of the changes. Defendants cite the fact that the change orders increased the value of the Subcontract from $170,200.00 to $2,577,012.00. Defendants also argue that the change orders altered Accutronics' scope of work under the Subcontract, from the relatively simple installation of metal zone distribution boxes to the installation of an entire fiberoptic telecommunications system. As the Court has already concluded, however, the Subcontract contemplated a scope of work that was much broader than the mere installation of zone distribution boxes. **Rather, the Subcontract's scope encompassed work such as the installation of fiberoptic and telecommunications cabling and included a $1,500,626 option that was priced by Accutronics itself. Defendants have not pointed to any undisputed material fact that would suggest otherwise, and they are therefore not entitled to summary judgment on the cardinal change defense** **In this case, Centex has argued that Accutronics' continued performance under the Subcontract constituted a waiver. Defendants have not demonstrated the absence of genuine disputes of material fact with respect to Centex's characterization of the continued performance. For this additional reason, the Court will deny Defendants' summary judgment motion as to their cardinal change defense."**	Subcontractor v. **(Contractor)**	Failed	**FC3: Failure to prove causation and/or resultant injury.** **FC5: Continued performance constituted waiver; Failure to highlight any undisputed material fact to prove that the performed works were not contemplated for and/or not considered part of its contractual obligations.**
CITY OF GILLETTE, WYOMING V. HLADKY CONSTRUCTION, INC	2008	"At the close of HCI's case in chief, upon the City's motion, the district court granted judgment as a matter of law on HCI's cardinal change claim. The jury was not instructed that upon a finding that one party breached the contract or the implied covenant, the other party was relieved from performing under the contract. Regardless of the evidence or arguments HCI presented, the case was given to the jury as a breach of contract and/or breach of the implied covenant case. Upon the jury finding that the City breached the implied covenant contained in the contract, HCI was entitled to recover reasonable attorney fees. The district court did not err in ruling as a matter of law that HCI was not judicially estopped from seeking attorney fees. **In its ruling, the district court stated that it was not persuaded Wyoming law recognizes the cardinal change doctrine; even if the claim is recognized, the facts were insufficient to support the claim; and, even if the facts were sufficient, HCI waived the claim by continuing to perform under the contract."**	Contractor v. **(Employer)**	Failed	**FC3: Failure to prove causation and/or resultant injury** **FC6:The Cardinal change doctrine is absent from the State's case law** **FC7: Continued performance constituted waiver;**

C&C Plumbing and Heating, LLP v. Williams County	2014	"In any event, the contracts in section 17.2.2 specifically provided that AGC "acknowledges and accepts the prospects of such delays, interferences and interruptions to the progress of the Project and to the Work as are inherent in the construction industry" and that AGC has "included compensation for such delays, interferences and interruptions in the Contract Sum." The district court found the project's "slow start" was attributable to delay-producing acts and occurrences "inherent in the construction industry," and this four-month period from April through July 2007 was "lost time that was never made up." **AGC's claim that requiring masonry work in winter conditions is a "cardinal change" to the contract is without merit. Under the circumstances, this cannot be considered "an alteration in the work so drastic that it effectively requires the contractor to perform duties materially different from those originally bargained for." 64 Am. Jur. 2d Public Works and Contracts (2011).** **We conclude the district court did not err in giving effect to the no damages for delay clause during the first four months of delays when AGC specifically contracted and included compensation in its contract for the same."**	Contractor v. **(Employer)**	Failed	**FC1: Changes were not substantial as to amount to a cardinal change to the contemplated scope of works** **FC5: Failure to highlight any undisputed material fact to prove that the performed works were not contemplated for and/or not considered part of its contractual obligations**.
RDA Construction Corp. v. Unites States	2017	**"RDA's cardinal change claim fails, because the record contradicts RDA's assertion that it did not expect the piles to break during the extraction process. On March 29, 2010, RDA submitted a demolition plan to the NAVFAC advising that. . .** **For these reasons, the court has determined that RDA did not prove that the NAVFAC caused any change to the contract work or the circumstances affecting that work, let alone a cardinal change that required RDA to perform duties materially different from those bargained for by the parties.** See Allied Materials, 569 F.2d at 563-64. Accordingly, Count V of the May 7, 2015 Second Amended Complaint is dismissed."	Contractor v. **(Employer)**	Failed	**FC3: Failure to prove causation and/or resultant injury.** **FC5: Failure to highlight any undisputed material fact to prove that the performed works were not contemplated for and/or not considered part of its contractual obligations**.

Turner Construction Company v. MJ Flaherty Company	2017	"As Judge MacDonald notes, if a cardinal change were established that might constitute a material breach of the Subcontract. However, proof of a breach of contract on the part of Turner would not be a basis for the court to Write a new subcontract for the parties that did not include any limitation on consequential damages. **Proof of a cardinal change constituting a breach would permit recovery of direct damages occasioned by that breach.** **The cases that seem closest to the issue presented by the instant case are those in which the court concluded that the contracting parties had departed so significantly from the terms of their contract that the plaintiff was entitled to recover the fair value of its services instead of under the contract, i.e., a quantum meruit recovery.** To the contrary, under Massachusetts law, clauses in construction contracts limiting the right to recover consequential damages have long been recognized and enforced as an appropriate means to "limit the expense and unpredictability of construction contract litigation." Costa v. Brait Builders Corp., 463 Mass. 65, 78 n.22 (2004). Indeed, the SJC has reflected on the utility of such clauses as a means to protect against claims just like those that Flaherty attempts to assert in this case: "Some of the consequential damages claimed by the plaintiff here, including his going out of business ... may provide a case in point." Id. In consequence, Flaherty's claims for indirect or consequential damage fail, as a matter of law, even if there is evidence to support a theory of cardinal change or contract abandonment in the summary judgment record. Moreover, at **present, the court does not believe that the issue of cardinal change, much less contract abandonment, can be presented without testimony from witnesses who performed or observed the work being done by Flaherty and can provide competent evidence of the effect that Project changes had on Flaherty, if they had any at all."**	Subcontractor v. (Contractor)	Failed	**FC3: Failure to prove causation and/or resultant injury.**
Gainesville Mechanical, Inc. v. Air Data Inc.	2019	"In its order, the arbitrator summarized the evidence briefly and determined that Gainesville Mechanical paid Air Data only$32,000, less than half the $72,770itwasentitledtounder itscontract.1Italsodeterminedthatdue to the directive of a general contractor on the construction project, Gainesville Mechanical instructed Air Data to work 7days a week for 10 hours a day for an extended period of time. Additionally, the arbitrator concluded that Gainesville Mechanical required Air Data to conduct testing on mechanical systems before the building was enclosed and even before Gainesville Mechanical's work and that of other trades was complete in the very areas where Air Data was asked to est. Gainesville Mechanical ultimately fired Air Data and hired another contractor to perform the work at a cost of over $149,985, at a time when the building was opened and occupied and the work could be performed by a single employee	**(Subcontractor)** v. Contractor	Succeeded	**SC2: Changes affected the entire undertaking of the contractor and/or what the parties have bargained for under the Contract.**

		[w]hile only rarely governing a construction dispute**, the Arbitrator determines that the facts of this case call for the application of the legal doctrine of cardinal change. . . . While the term cardinal change is primarily utilized in Federal Government construction cases, Georgia and other states often adopt other terminology such as quantum meruit, abandonment of contract, and fundamental breach**. A Nevada decision explained: The cardinal change doctrine serves to provide a breach remedy for contractors who are directed to perform work which is not within the general scope of the contract and which is not redressable under the contract. Thus a cardinal change occurs when the work is so drastically altered that the contractor effectively performs duties that are materially different from those which the contractor originally bargained. 3(Punctuation omitted; emphasis omitted.)”			
Durr Mechanical Construction Inc. v. PSEG Fossil, LLC	2021	“Those peculiarities do not arise in contracts between private parties, which may account for the doctrine’s absence from the New Jersey case law. . . “The cardinal change doctrine is based on the notion that even though an express contractual provision exists governing changes to the contract . . . some changes are nonetheless ‘so severe’ that extracontractual relief is appropriate.” Ebenisterie Beaubois Ltee v. Marous Bros. Constr., Inc., No. 02 CV 985, 2002 WL 32818011, at *4 (N.D. Ohio Oct. 17, 2002). Under New Jersey law, however, express provisions prevail over implied provisions. Kas Oriental Rugs, Inc. v. Ellman, 926 A.2d 387, 392 (N.J. Super. Ct. App. Div. 2007). That principle is hard to square with a doctrine recognizing extracontractual relief, a mismatch that has persuaded federal courts applying similar state laws to reject the cardinal change doctrine. For starters, the doctrine grew out of peculiarities of federal government contracting law—particularly, the need to temper the potential unfairness resulting from the federal government’s paramount authority to alter contracts in the public interest. **Those peculiarities do not arise in contracts between private parties, which may account for the doctrine’s absence from the New Jersey case law. Indeed, the doctrine is in considerable tension with principles of New Jersey law.** “The cardinal change doctrine is based on the notion that even though an express contractual provision exists governing changes to the contract . . . some changes are nonetheless ‘so severe’ that extracontractual relief is appropriate.” Ebenisterie Beaubois Ltee v. Marous Bros. Constr., Inc., No. 02 CV 985, 2002 WL 32818011, at *4 (N.D. Ohio Oct. 17, 2002). Under New Jersey law, however, express provisions prevail over implied provisions. Kas Oriental Rugs, Inc. v. Ellman, 926 A.2d 387, 392 (N.J. Super. Ct. App. Div. 2007). That principle is hard to square with a doctrine recognizing extracontractual relief, a mismatch that has persuaded federal courts applying similar state laws to reject the cardinal change doctrine. Ebenisterie, 2002 WL 32818011, at *4 (Ohio law); Mellon Stuart Constr., Inc. v. Metro. Water Reclamation Dist. of Chi., No. 94 C 1915, 1995 WL 124133, at *5 (N.D. Ill. Mar. 20, 1995) (Illinois law); Litton Sys., Inc. v. Frigitemp Corp., 613 F. Supp. 1377, 1382 (S.D. Miss. 1985) (Mississippi law). I find no compelling reason to recognize a cardinal change doctrine claim under New Jersey law, and decline to do so. The motion to dismiss Count 3 is therefore granted”	Contractor v. **(Employer)**	Failed	**FC6: The Cardinal change doctrine is absent from the State's case law and is considered in considerable tension with principles of New Jersey case law.**

The deduced success and failure criteria were summarized vide the tables below:

Table 18: Cardinal Change Claims Failure Criteria (as Deduced from Examined Cases)

	Failure Criteria Deduced From Examined Cases									
	FC1	**FC2**	**FC3**	**FC4**	**FC5**	**FC6**	**FC7**	**FC8**	**FC9**	
Cases	Changes were not substantial as to amount to a cardinal change to the contemplated scope of works	Could not separate its impacts from the other party's related impacts	Failure to prove causation and/or resultant injury.	Breached the contract when performance was suspended	Failure to highlight any undisputed material fact to prove that the performed works were not contemplated for and/or not considered part of its contractual obligations.	The cardinal change doctrine is absent from the State's case law	Continued performance constituted waiver;	Deviation from the project requirements where attributed to plaintiff; plaintiff failed to abide by its requirements of the contract	Could not prove that a fundamental change in the character of the work had taken place and thus no costs had been experienced whose likelihood had not been foreseeable.	**Frequency of Failure Criteria per Case**
C2	√	√	√							3
C4	√									1
C8			√							1
C9			√					√		2
C11			√						√	2
C14	√									1
C15								√		1
C16	√		√							2
C17				√						1
C19			√		√					2
C20			√			√	√			3
C21	√				√					2
C22			√		√					2
C23			√							1
C25						√				1
Total	**5**	**1**	**9**	**1**	**3**	**2**	**1**	**2**	**1**	**25**

Table 19: Cardinal Change Claims Success Criteria (as Deduced from Examined Cases)

	Success Criteria Deduced From Examined Cases				
Case Code	**SC1** Introduced changes are beyond what the parties have reasonably anticipated under the contract and/or beyond the general scope thereof	**SC2** Changes affected the entire undertaking of the contractor and/or what the parties have bargained for under the contract.	**SC3** Employer abused the use of the change order clause.	**SC4** Defendant failed to prove that the plaintiff's continued performance constituted waiver; and to prove that the performed works were within the plaintiff's obligations under the contract.	**Frequency of Success Criteria per Case**
C1	√				1
C3	√				1
C5	√	√			2
C6	√	√	√		3
C7	√	√			2
C10	√				1
C12		√	√		2
C13				√	1
C18		√			1
C24		√			1
Total	**6**	**6**	**2**	**1**	**15**

5.3.3 What Constitutes a Cardinal Change

In additions to the success and failure criteria deduced from the studied cases, in order to be able to form a clearer picture of what constitutes a cardinal change, the major considerations that have influenced courts' decisions have been identified in successful cases involving cardinal change claims. These considerations have been are highlighted vide Table 20 below:

Table 20: Major Considerations of what Constitutes a Cardinal Change

Case	Finding
General Contracting and Construction Co. v. U.S., 84 Ct.Cl. 570 (1937).	The court found a cardinal change because of the quality of the change not because of the magnitude of the change.
Saddler v. U.S., 287 F.2d 411 (Ct.Cl. 1961	The court found a cardinal change because of the magnitude of the change and not because of the quality of the change.
Luria Brothers and Company, Inc. v. U.S., 369 F.2d 701 (Ct.Cl. 1966).	The court found a cardinal change because of the change of the quality of the project not because of the magnitude of the overruns in time and money.
Air-A-Plane Corp. v. U.S., 408 F.2d 1030 (Ct.Cl. 1969)	The court noted that the Board of Contract Appeals' finding that, because of the extensive changes, a different type of contract was better suited to the project could provide a factual basis for finding that a cardinal change had occurred.
Peter Keiwit Sons' Co. v. Summit Construction Co., 422 F.2d 242 (8th Cir. 1969).	The court held that the financial magnitude of changes, standing alone, constituted a breach of the contract.
Edward R. Marden Corp. v. U.S., 442 F.2d 364 (Ct.Cl. 1971)	The court noted that, qualitatively, the project had remained the same-a hangar. The court based its decision "on the sheer magnitude of reconstruction work caused by the alleged defective specifications.
Westinghouse Electric Corp. v. Garrett Corp., 437 F.Supp. 1301 (D .Md. 1977).	The court found that the failure to supply the drawings was a material change which rose to the level of a breach. The Garrett court based its finding of breach on the adverse qualitative impact on Garrett's construction methods, not on the quantitative nature of the changes.
Allied Materials and Equipment Co., Inc. v. U.S., 569 F.2d 562 (Ct.Cl. 1978).	The court found a possible cardinal change based solely on the qualitative burden placed on the contractor's construction methods.

Universal Contracting & Brick Pointing Co. v. United States (1990)	The court noted that the contract must be viewed as a whole in determining whether there has been a cardinal change, which may include a determination of whether the contractor's difficulties in performance were precipitated in any way by the government's conduct.
Airprep Technology, Inc. v. U.S., 30 Fed.Cl. 488 (1994)	The court found that the cost increases as a result of instructed change orders constituted cardinal changes which justified Airprep termination of the contract for breach.
Becho Inc. v. USA (1997)	The court noted that the determination whether a change is cardinal plainly is more than "a mere exercise in semantics, it is intensely factual almost inevitably obliging the court to receive and weigh evidence". The court shall consider the following factors: (i) whether there is a significant change in the magnitude of work to be performed; (ii) whether the change is designed to procure a totally different item or drastically alter the quality, character, nature or type of work contemplated by the original contract; (iii) whether the cost of the work ordered greatly exceeds the original contract cost.
J.A. Jones Construction Co. v. Lehrer McGovern Bovis (2004)	The court noted that in this case, the overall physical characteristics of Jones's work changed very little. The real question, however, is whether the entirety of the changes and impacts on Jones's work were so extensive as to force Jones to perform works beyond the confines of the contract. The court also highlighted that the evidence required to demonstrate the occurrence of cardinal change is similar to that required by the contract-abandonment theory
Durr Mechanical Construction Inc. v. PSEG Fossil, LLC (2021)	The court considered the application of the Cardinal Change Doctrine as being in considerable tension with the state law.

As previously highlighted above, each case has its own factual uniqueness and must be analyzed in light of its own circumstances. Notwithstanding the above cases do allow the establishment of a sort of generalization regarding cardinal change claims:

5.3.3.1 Qualitative factors:

Courts have found that cardinal changes have been induced because of the qualitative impact of the changes rather than the quantitative impact (General

Contracting and Construction Co. v. U.S., 84 Ct.Cl. 570 (1937); Luria Brothers and Company, Inc. v. U.S., 369 F.2d 701 (Ct.Cl. 1966).; Allied Materials and Equipment Co., Inc. v. U.S., 569 F.2d 562 (Ct.Cl. 1978); Edward R. Marden Corp. v. United States (1971)).

Based on the explored cases qualitative changes can rise to the level of a cardinal change in cases whereby:

- There have been fundamental changes to the design (Edward R. Marden Corp. v. United States (1971); Westinghouse Electric Corp. v. Garrett Corp, 1977; Fuller Co. v. Brown Minneapolis Tank & Fabricating Co.,*(1987*); Merril Eng'g Co. v. United States (1931))
- Works are outside the scope of the contract and/or not substantially different from what was bargained for upon entering into the contract (Allied Materials and Equipment Co., Inc. v. U.S., 569 F.2d 562 (Ct.Cl. 1978); Cray Research, Inc. v. Department of Navy, 556 F. Supp. 201, 203 *(*D.D.C 1982).; Albert Elia Building Co. v. N.Y. State Urban Dev. Corp., 54 A.D. 2d 337, 388 N.Y.S.2d 462, 467 (App. Div. 1976; J.A. Jones Construction Co. v. Lehrer McGovern Bovis (2004))
- Abandoned specifications and/or construction procedures (L.K. Comstock & Co. v. Becon Construction Co. (1993)).
- Conditions under which the contractor expected to perform the work had been substantially altered or changed by the employer/engineer (Edward R. Marden Corp. v. United States (1971); Housing Authority of Texarkana v. E.W. Johnson Constr. Co., 264 Ark. 523, 573 S.W.2d 316 (1978); L.K. Comstock & Co. v. Becon Construction Co. (1993)).

In such cases, courts have found that the instructed changes have risen to the level of a cardinal change despite whether the magnitude of changes is relatively low or high.

5.3.3.2 Quantitative Factors:

From the examined cases, the major quantitative factors examined by courts have been:

- The changes to contract price (Edward R. Marden Corp. v. United States (1971)).
- The changes/impact to time for completion (C. Norman Peterson Co. v. Container Corp. of America, 172 Cal. App. 3d 628, 218 Cal. Rptr. 592 (1985)).
- Changes to quantities and amounts (Saddler v. U.S., 287 F.2d 411 (Ct.Cl. 1961)
- The individual and cumulative impact of changes (Atlantic Dry Dock Corp. v. United States, 773 F. Supp. 335 (M.D.Fla.1991)).

It shall be noted that these factors are not equally significant. To regard a change as rising to the level of a cardinal change, courts have given more consideration to the magnitude of the cost overruns and changes in quantities that have been experienced by the contractor. In some cases, courts have not entertained a cardinal change claims unless the impact on the contract price have risen to the level of nearly 100%. Moreover, the above factors are highly interrelated and can have a combined effect. The overall impact of changes shall be looked at as a whole. Notwithstanding, changes which reduce the amount of work or expense of the contract generally cannot be considered to constitute a cardinal change thereto (Harrison, 1997).

5.3.4 Legal Consequences:

5.3.4.1 Abandonment and Destruction of Contract

Most jurisdictions that recognize and apply the cardinal change doctrine makes no distinction between the latter and the doctrine of abandonment of contract (Silberman, 2004). Both doctrines allow the contractor to claim and recover the additional costs that have been encountered (General Contracting and Construction Co. v. U.S., 84 Ct.Cl. 570 (1937); Luria Brothers and Company, Inc. v. U.S., 369 F.2d 701 (Ct.Cl. 1966); Allied Materials and Equipment Co., Inc. v. U.S., 569 F.2d 562 (Ct.Cl. 1978); Edward R. Marden Corp. v. United States (1971)). Notwithstanding, the interpretation of both doctrines varies between different jurisdictions. For private construction projects, some form of the cardinal change and abandonment doctrine has been applied and recognized under the laws of more than 23 states (Silberman, 2004).

For instance, in the case of Amelco Electric v. City of Thousand Oaks, the California Supreme Court distinguished the doctrines, calling them "fundamentally different". According to the court, the contractor is entitled - under an abandonment claim – to recover total cost (less payment received) for works executed both before and after the work was abandoned (Silberman; 2004). On the contrary, in the case of a cardinal change claim, the contractor would only be entitled to breach of contract damages for the additional work constituting cardinal change (Silberman, 2004). Moreover, in some jurisdictions, the abandonment doctrine was only adopted for private contracts, but has not been addressed for public contracts.

Accordingly, different jurisdictions recognize and approach abandonment and cardinal changes differently. The contractor shall be totally aware of the jurisdictions and law governing the contract.

In many cases the law has destroyed the contract in cases when the employer/engineer ordered a material or substantial change and/or a big number of small changes (White, 2006). Insisting on substantial changes to the contemplated scope of works has been considered a form of prevention exercised by the employer and thus can be regarded as a breach of contract by the employer (Corbin on Contract, 2001). Citing Pennsylvania Law “If a breach constitutes a material failure of performance, then the non-breaching party is discharged from all liability under the contract ... a party who has materially breached a contract may not complain if the other party refuses to perform its obligations under the contract" (Cornell, 2000). In many cases accordingly, cardinal changes were considered as a material breach of contract that relieves the non-breaching party from further performance of the contract (Air-A-Plane Corp., 1969; U.S; General Dynamics Corp., 1978; Allied Materials & Equip. Co., 1978). In effect, the contract can no longer be enforced; it is considered to have become destructed (Nancy J.D, 2006). Federal law has made it clear that the contract can be destroyed through one large change or through a number of small changes whereby each case must be “analyzed on its own facts and in light of its own circumstances, giving just consideration to the magnitude, and quality of the change ordered, and their cumulative effect upon the project as a whole” (Wunderlich Constr. Co. v. Unites States (1965).

After establishing that a cardinal change has been induced, parties to the contract can mutually agree to abandon the contract; such abandonment can be either expressed or implied (Fru-Con/ F1uor Daniel Joint Venture v. Corrigan Brothers, Inc (2004)). In cases where the contractor manages to persuade the court that it had experienced a cardinal change, the contractor can recover its actual costs upon a quantum meruit (J.A. Jones Construction Co. v. Lehrer McGovern Bovis (2004))).

5.3.4.2 Contractor's Remedies

If a cardinal change has been established and the court considered that the contract had become abandoned/destroyed, "such a material breach has the effect of freeing the contractor of its obligations under the contract, including its obligations under the dispute clause" (Alliant, 1999). When the contract is destroyed, the contractor will be entitled to recover its losses under concepts of quantum meruit and/or promissory estoppel (Nancy J.D, 2006). The concept of promissory estoppel allows the promisee (such as the contractor) under conditions where it is reasonable to expect payment from the promisor (such as the employer) for performed works (Corbin, 2001; Farnsworth, 1998; O'Brien & Gere Technical Services Inc. (2004)). The recovery is not necessary to be the total cost of performance knowing that in some cases courts have considered that the application of the total cost method might sometimes be inappropriate (J.A. Jones Construction Co. v. Lehrer McGovern Bovis (2004)). In J.A. Jones Construction Co. v. Lehrer McGovern Bovis (2004), the court awarded the contractor $5.4 million in quantum meruit damages considering that such an amount is a reasonable value for the contractor's services. Accordingly, the amount of recovery might be a reasonable amount which may not be the contractor's total cost of performance in cases where the contractor had inflated its costs or otherwise engaged in unreasonable actions involving inflating costs (Nancy J.D, 2006).

5.3.4.3 What should Contractor's do when faced with a Cardinal Change

Generally, a contractor will proceed with the change to the works instead of refusing to perform, because of the risk associated with not being able to invoke the cardinal change principle (Stockenberg, 2002). If the court ruling considered that the amount of changes do not rise to the level of a cardinal change, then contractor will be at a high risk of defaulting in case it opted to suspend performance; thus it may attempt to perform the works and sue later (L.K Comstock & Co. v. Becon Const. Co., 932 F. Supp. 906 (1992); Hensel Phelps Const. Co. v. King Country (1990)). The contractor cannot hedge by seeking a declaratory judgment to whether the change/changes quantify to a cardinal change and/or are beyond the scope of the contract (Valley View Enters., Inc. v. United States 1996).

Citing the court in L.K. Comstock & Co. v. Becon Construction Co. (1993), the court stated that **"**In summary, a number of courts in decisions based upon state law have applied the doctrine of cardinal change. While it may not always bear the name "cardinal change," and may or may not be clearly borrowed from federal procurement law, the core theory that when an employer orders changes beyond the scope of the work agreed to be performed the contractor is entitled to damages (in some form) for breach, has been widely recognized. As discussed above, moreover, situations where ordered changes exceed the general scope of the contract are sometimes addressed under the principle of abandonment. Regardless of which theory is applied, the result is the same: the party performing the work is entitled to seek a remedy outside the contract for the reasonable value of work performed."

In addition to the above, to protect its rights, the contractor shall always keep contemporary records of all costs and expenses involving changes throughout the project timeline (Nancy J.D, 2006).

In addition, the contractor shall always reserve its right under one of the destruction/abandonment of contract theories. "An assent by the contractor and proceeding with the work as demanded, without reservation of rights, will operate as a variation of the original contract leaving no claim for damages" *(*Oberer Constr. Co. v. Park Plaza, Inc. (1961); Fuller Co. v. Brown Minneapolis Tank & Fabricating Co. (1987)). When serving such reservation of right/notice, the contractor shall record that it had experienced a material breach of the contract and its reserves its right to collect damages under the law (Nancy J.D, 2006).

In addition to the above, and in light of the deduced success criteria from the examined cases, the contractor/claimant - in order to increase its chances of putting forward a successful claim - must:

1. Establish nexus between the unanticipated changes and additional costs.
2. Prove that changes are substantial to the contemplated scope of work.
3. Try to segment and separate the employer's impact from contractor's related impacts.
4. Make sure that the prevailing law allows for recovery under the cardinal change doctrine.
5. Prove that the anticipated changes were unforeseeable by the time of entering into the contract.

5.4 Conclusion and Concluding Remarks:

5.4.1 Interconnections between Success and Failure Criteria

It is evident that the deduced failure and success criteria are interconnected and in some cases mirror each other;

1. FC1 & FC5 & FC9 v. SC1: The contractor should be able to prove that a cardinal change has been induced from either a qualitative or a quantitative

perspective or both (SC1). The contractor's ability to prove the latter, is considered the most recurring success criteria (SC1) besides (SC2). On the other side, the contractor's failure to prove that changes were substantial as to amount to a cardinal change (FC1), and to highlight any undisputed material fact to prove that the performed works were not taken into consideration and/or not considered part of its contractual obligations (FC5) were considered the second and third most recurring failure criteria respectively. Thus the contractor's failure to prove that there had been a fundamental change to the works whose impact was unforeseeable will disallow the latter to recover any incurred losses (FC9).

2. FC8 v. SC2: The contractor shall be able to prove that the deviation from what was originally bargained for under the contract is not merely attributed to its failure to abide by the contract requirement (FC8). The contractor shall thus prove that the changes affected the entire contractual undertaking and what the parties have bargained for under the contract (SC2).

3. FC6 v. SC3: The contractor shall make sure that although the employer might have abused its power in ordering a large number of change orders (SC3), the concept of cardinal change is acknowledged under the prevailing law (FC6).

4. FC4 & FC7 v. SC4: As previously highlighted in Chapter 4, the contractor may be barred from collecting any remedy for cumulative impact under the doctrine of accord and satisfaction whereby continued performance might be considered to constitute waiver to recover under the cardinal change doctrine (FC7). On the contrary, the contractor's attempt to suspend performance might be considered a breach of contract and disallow the latter to recover any incurred impact (FC4).

However, in some cases, courts have not considered continued performance to constitute waiver (SC4).

5. FC2 & FC3: As was deduced in Chapter 4, proving causation, resultant injury and foreseeability has always been a vital part in proving any claim and is considered to be the most recurring failure criterion (for both cumulative impact and cardinal change claims). In the case of cardinal change claims, and similarly to cumulative impact claims, the contractor shall utilize scientific quantitative methods and project records to be able to prove causation and resultant injury (FC3) and separate its impacts from employer's related impacts (FC2).

The below figure further illustrates the above:

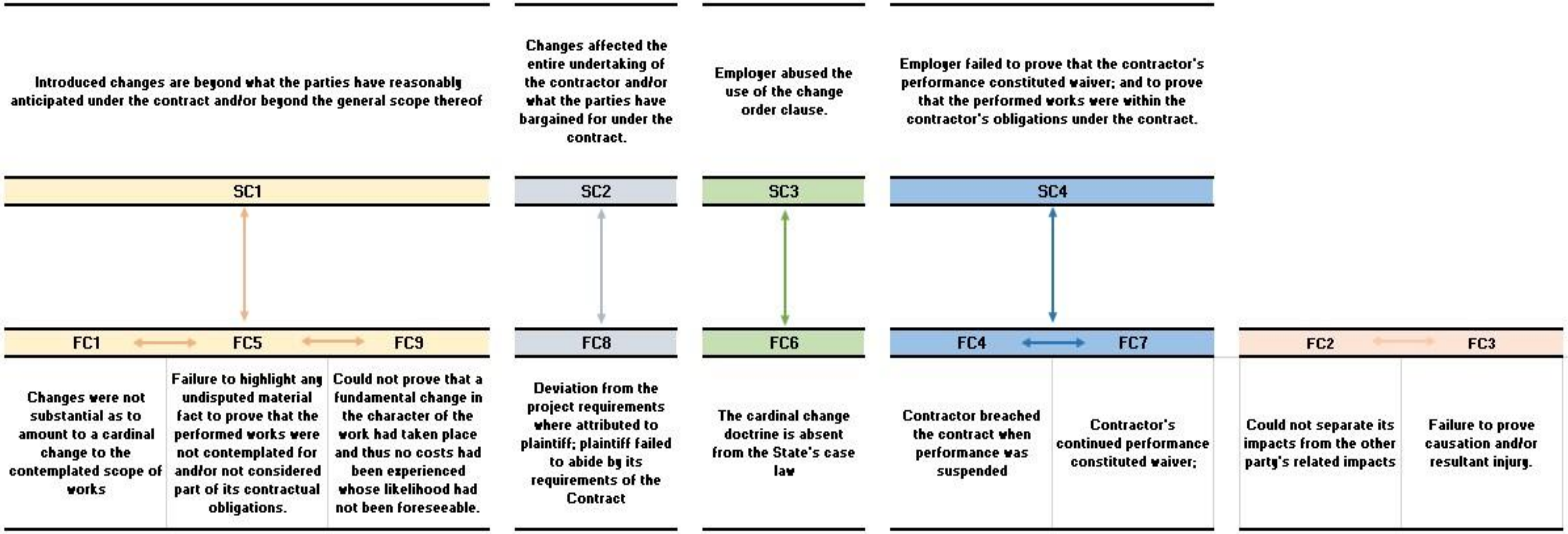

Figure 11: Interconnections between success and failure criteria pertaining to cardinal change claims

5.4.2 Key Takeaways:

Following the analysis of both the literature and case law, the key takeaways for this chapter can be highlighted below:

1. Cardinal change can be either qualitative or quantitative. It can be as a result of the quantity of the changes (magnitude in terms of money and time overruns) or the quality of the changes (changes qualitatively altered what have been bargained for under the contract).
2. Each case has its own factual uniqueness and shall be analyzed in light of its own circumstances.
3. Different jurisdictions recognize and approach abandonment and cardinal changes differently. The contractor shall be totally aware of the jurisdictions and laws governing the contract. In many cases, the contract had been considered abandoned considering that the substantial changes to the contemplated scope of works was a form of prevention exercised by the owner and thus can be regarded as a breach of contract by the owner.
4. Upon facing a cardinal change, generally contractors opt to proceed with the changes to the works instead of refusing to perform, because of the risk associated with not being able to invoke the cardinal change principle.
5. To prove a cardinal change, the contractor shall establish nexus, prove causation and resultant injury, make sure that the prevailing law allows for recovery under the cardinal change doctrine, and prove that the anticipated changes were unforeseeable by the time of entering into the contract.
6. If a cardinal change has been established, the contractor can recover its losses upon a quantum meruit (reasonable value of work performed).

7. The contractor should try to serve a notice and record that it had experienced a material breach of the contract and always reserve its right to collect damages under the law.

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

6.1 Summary of work:

The objective of this research was to investigate the different employers' and contractors' perspectives in expressing and treating the large volume of construction contract variations. In order to attain such objective, a literature review was conducted to identify the different types of change orders, causes and effects of the latter, claims related thereto, the elements of a successful claim, and the different quantification methods used by contractors for cumulative impact and global claims. Then, two case studies were analyzed highlighting how the large volume of contract variations can be viewed and expressed differently by the employer and the contractor along with the different strategies deployed by each party to try to quantify the impact of the substantial number of change orders; employers' defense mechanisms and contractors' strategies to improve its positions were also identified. Consequently, cumulative impact claims and cardinal change claims were defined and the different success and failure criteria were identified after conducting both a literature and a case law review. Moreover, guidelines were established to clarify what qualifies as a cardinal change to the contemplated scope of works along with the analysis of different legal repercussions in case a cardinal change has been induced.

The merits of this research will guide contractors to the admissibility and viability of cumulative impact claims and cardinal change claims which can be utilized by employers and contractors to treat the large volume of construction contract variations in a scientific/contractual manner rather than opting for un-orthodox and/or ill-founded strategies that have higher chances of resulting in a dispute between the parties of the contract and a rather chaotic manner of treating the large volume of contract variations.

6.2 Research Implications and Recommendations

6.2.1 Research Implications

The large volume of contract variations can be viewed and expressed differently by the employer and the contractor. This gives rise to different perspectives in relation to the treatment of the large volume of changes and thus to different approaches in packaging contract variations related claims. This research was able to fill significant gaps and inconsistencies in the literature in terms of:

1. Clearly defining what constitutes cumulative impact claims and cardinal change claims.
2. Deducing the key success and failure criteria for cumulative impact claims and cardinal change claims after conducting both a literature review and a case law review.
3. Providing guidelines that shall establish whether a change is considered a cardinal change and the legal consequences if it has been induced.
4. Investigating different contractors' and employers' strategies and perspectives in dealing with the large volume of changes.

6.2.1.1 Case Studies Versus Deduced Success and Failure Criteria

6.2.1.1.1 Case Study 1: Item Fully Impacted v. Item Partially Impacted

Following the findings of Chapter 5 of this research regarding what constitutes a cardinal change and the different success criteria of cardinal change claims, it is thereby evident that the contractor's allegation that the instructed variation orders had qualitatively altered the design and fully affected the elevators' package as a whole is very ill-founded and faulty. The below can be noted regarding this case:

1. There had been no fundamental change to the whole design of the project; the instructed variations only impacted the tiling material and layout inside the elevators' car; the contractor's allegation that the whole value of the elevators package has been impacted is irrational and illogical since the instructed variation only impacted circa 8% of the overall elevator's package (opposed to 10% of the contract price as claimed by the contractor).
2. The instructed works were not considered outside the scope of the contractor and/or substantially different from what had been bargained for upon entering into the contract.
3. Conditions under which the contractor was expected to complete the works had not been substantially altered.
4. The changes to the contract price and quantities were minimal and not as inflated by the contractor.
5. Contractor failed to prove causation and resultant injury (FC3 of Chapter 5), failed to prove that the changes were substantial to amount to a cardinal change to the works (FC1 of Chapter 5), and failed to prove that a fundamental change

to the character of the work had taken place and/or works were not considered upon entering the contract (FC5 and FC9 of Chapter 5).

Based on all the above, it is clearly evident that the contractor had a rather inaccurate perspective especially in trying to package its claim as a cardinal change claim. The contractor's approach proved to be very weak and not based on any solid argument and/or contractual basis.

6.2.1.1.2 Case Study 2: Absolute v. Net Impact on Contract Price

Upon the findings of Chapters 3 and 4, it can be underlined that the employer's allegation that the overall absolute impact of the instructed variation orders is nominal is considered unsound. The below can be noted regarding this case:

1. The contractor can pursue a cumulative impact claim on the basis of experiencing a large number of change orders that in turn impacted productivity, efficiency, and performance both on changed and unchanged works (SC1 of Chapter 4).
2. The contractor can also prove that at the time of pricing every change order, it was unable to foresee the ripple-effect of the multiplicity of change orders (SC2 of Chapter4) and that it did not knowingly waive its right to assert a cumulative impact claim (SC4 of Chapter 4).
3. However, the contractor should be able to prove causation and resultant injury (SC3 and FC2 of Chapter 4) which is the major criteria in proving cumulative impact. Moreover, the contractor should also attempt to establish a contractual bases to its claim following careful scrutiny of the conditions of the contract; in Chapter 3 of this research it was highlighted that different conditions of

contracts approach the issue of cumulative impact claims and the volume of changes differently.

4. Contractor should make sure that it did not sign any release language that prevents it from recovering potential cumulative impacts.
5. The contractor’s position is stronger than that of the employer, especially since the number of changes is considerably high which evidently might not be considered in the contract. The contractor, in this case might try to pursue a cardinal change claim also on the basis of the absolute impact of variation orders that altered the scope qualitatively and/or quantitatively.

6.2.2 Recommendations

Based on the merits of this research, it is thereby recommended to:

1. Always determine a clear procedure to negotiate changes and determine its impacts: the parties to the contract can agree on a clear procedure for determining the impacts of change orders. Such a procedure can be clearly specified in the conditions of the contract.
2. Account for all foreseeable work, risks, and working conditions: while preparing its bid, the contractor shall try to construct a risk register that incorporates all contingencies and risks which the contractor might be prone to. The contractor shall consequently try to negotiate these risks and/or otherwise attempt to incorporate them within its bid price. If the contractor’s accounting system cannot segregate change orders costs and man-hours, the contractor should always reserve its right to recover indirect costs (if any) at a later stage since any impact deemed foreseeable by the contractor while negotiating change orders,

should be included in the contractor's assessment and therefore is not recoverable under a cumulative impact claim.

3. Be acquainted with the prevailing laws: different jurisdictions recognize and approach abandonment of contract, cardinal changes, and cumulative impact claims differently. The contractor should be totally aware of the jurisdictions and laws governing the contract.

4. Maintain sufficient records and documentation: the contractor and the employer should properly document all information available at the time it priced that change order and keep contemporary records to establish afterwards that cumulative impacts were not foreseeable. The contractor shall try to be proactive through projecting the impact of any change on its activities and progress of works. While doing so, the contractor should bear in mind and keep an eye on its productivity rates and update them on a regular basis.

5. Establish a productivity baseline: the contractor should always attempt to resource load its programme of works and maintain effective and regular tracking of its productivity rates for the various trades and activities. For each activity the baseline should establish one reasonable productivity rate per crew which should subsequently be the basis of productivity fluctuations taking into consideration the learning process.

6. Use experts and studies: the parties to the contract should leverage resorting to qualified experts and studies to try to estimate the synergistic effect of change orders and to prove causation and resultant injury and that the overrun was not merely due to contractor's inefficiencies. Such studies and experts should be able to provide a level of scrutiny accepted by courts.

7. Serve a notice for potential cost/time impacts: the contractor should always commit to serving a notice for prospective cost and time impacts even though it had agreed and signed on the individual impact of a certain change order. If the contractor did not reserve its rights to subsequently recover any potential impact changes, it might be barred from doing so under the doctrine of accord and satisfaction especially in cases where the signed change orders include release language.

6.3 Limitations:

The scope of this study is limited to the following:

1. The comparison and analysis of the standard forms of contracts was only limited to a number of international standard forms and not all forms used in the industry.
2. The two case studies were selected based on the availability of the related projects' records and the nature of the changes. More case studies can be analyzed highlighting the difference between employers' and contractors' perspectives towards the treatment of the large volume of construction contract variations.
3. Case law reviews for Chapters 4 and 5 were limited to 18 and 25 cases respectively. Accordingly, reviewing more cases would definitely result in more lessons learned and in additional criteria not covered under this research.
4. Case law reviews only covered the aspects of cumulative impact claims and cardinal change claims under common law cases only.

6.4 Future work:

For future work related to this field**,** the following is recommended:

1. Investigating and looking for more cases related to cumulative impact claims, and cardinal change claims. The aforementioned will either fortify the deduced success and failure criteria highlighted in this research, or identify new criteria based on court rulings.
2. Analyzing the different quantitative methods and methodologies that have been accepted by courts and used by contractors to prove cumulative impact claims and cardinal change claims. The accuracy, efficiency, data processing, factors utilized, advantages and disadvantages of every technique can be further investigated to compare all the available techniques and allow the parties to the contract to utilize the technique that fits the project the most.
3. Identifying and proposing guidelines that can be followed by contractors and employers to avoid the burden of dealing with complex claims similar to cumulative impact and cardinal change claims.
4. Identifying change management procedures that can be utilized to minimize and effectively manage the impact of change orders.

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